UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA

SAN FRANCISCO DIVISION

IN RE OPTICAL DISK DRIVE PRODUCTS ANTITRUST LITIGATION	No. 3:10-md-2143 RS
	DECLARATION OF DR. KENNETH FLAMM IN SUPPORT OF INDIRECT PURCHASER PLAINTIFFS' REVISED MOTION FOR CLASS CERTIFICATION
	DATE ACTION FILED: Oct. 27, 2009
This Document Relates to: ALL INDIRECT PURCHASER ACTIONS	

*** * * FILED UNDER SEAL * * ***

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I, KENNETH FLAMM, hereby declare as follows:

I. EXPERIENCE AND QUALIFICATIONS

1. I have been undertaking research, and publishing books, articles, and reports on the computer industry for approximately 35 years. I have written or edited seven peer-reviewed books, and over a dozen peer-reviewed articles on economic issues in the semiconductor, computer, and telecommunications industries over this period. So I believe it fair to say that I have deep economic expertise on the economics of this particular market, and industrial competition in the computer industry, that long predates this litigation. The analysis and opinions found in this and my previous reports are based on this experience and expertise, as well as documents, testimony, and analysis reviewed over the relatively short period this litigation has been before this Court. My current curriculum vitae is attached to this report as **Exhibit 1**.

2. I submit this declaration to supplement my testimony in the [Corrected] Declaration of Dr. Kenneth Flamm in Support of Plaintiffs' Motion for Class Certification (dated June 24, 2013) ("Flamm I") and the Declaration of Dr. Kenneth Flamm in Further Support of Indirect Purchaser Plaintiffs' Motion for Class Certification (dated February 18, 2015) ("Flamm II"), both filed in this action.

3. My compensation for time spent on this matter is currently $750 per hour. This compensation does not depend on the opinions and conclusions I reach or the result of this lawsuit. I have been assisted in my analysis by staff at Christensen Associates, who have worked on this matter under my supervision and direction. My analysis of this matter is continuing, and I reserve the right to supplement and revise my opinions as additional information becomes available to me. **Exhibit 2** lists the materials I have relied upon in preparing this declaration.

II. NEW PROPOSED CLASS

4. It is my understanding that the indirect purchasers are requesting certification of the following revised classes:

> **Proposed Class**: All persons and entities who, as residents of [**the United States or State**] and during the period April 2003 to December 2008, purchased new for their own use and not for resale: (i) a computer with an internal ODD; (ii) a stand-alone ODD designed for internal use in computers; or (iii) an ODD designed to be attached externally to a computer. ODD refers to a DVD-RW, DVD-ROM, or COMBO drive manufactured by one or more Defendants or their coconspirators. Excluded from the class are any purchases of Panasonic-branded computers.
>
> **Proposed Subclass**: All persons and entities who during, as residents of [**the United States or State**] and during the period April 2003 to December 2008, purchased new for their own use and not for resale any of the following Dell or HP-branded products: (i) a computer with an internal ODD; (ii) a standalone ODD designed for internal use in computers; or (iii) an ODD designed to be attached externally to a computer. ODD refers to a DVD-RW, DVD-ROM, or COMBO drive manufactured by one or more Defendants or their co-conspirators.

III. SUMMARY OF CONCLUSIONS

5. I have been asked by counsel for the indirect purchaser plaintiffs to review this Court's October 3, 2014 Order Denying Motions for Class Certification and to address some of the concerns raised by the Court. In response to this Court's opinion, I have performed the following additional analysis:

(a) A new cointegration analysis, studying an expanded dataset using transactional data from ODD producers accounting for 86 percent of industry sales, confirms the existence of cohesive equilibrium relationships among prices for DVDRW, DVDROM, and Combo drives sold to different purchaser groups. This implies that successful collusion would have had market-wide impact for all direct purchasers.

(b) A new Granger causality analysis studying this same expanded dataset establishes that collusive increases in ODD prices for Dell and HP drive purchases would have created collateral impacts on purchase prices for other customers of these drives.

(c) An augmented multivariate regression model of the overcharge—collusive impact—on distinct types of drives sold to distinct groups of purchasers shows that such a model is capable of distinguishing between periods of time, types of ODD drives, and groups of purchasers where statistical tests show conclusive evidence of impact, and periods of time, types of drives, and groups of purchasers where evidence is less conclusive. The preliminary results from an exemplary

demonstration of this model are economically plausible, and suggest significant impacts on all purchasers of DVD-RWs, DVD-ROMs, and COMBO drives, during some portions of the class period.

(d) Additional empirical analysis of actual retailer sales practices that establishes that even for the subset of retailers favoring particular price points, small discounts and price reductions are commonly used to stimulate sales of even the most expensive computer models.

(e) A new analysis of empirical evidence showing that where retailers use target price points for initial pricing of new pre-configured computer models, a negotiated process with computer OEMs establishes a set of components and features for the new computer models that is sensitive to component costs, and is designed to hit a specific target cost for both the computer manufacturers costs and the retailer's computer procurement cost from the OEM. As a consequence, increases or decreases in computer component costs trigger removal or addition of higher quality features in the design of new pre-configured computer models.

(f) New empirical analyses showing that quality of all components is increasing while prices are declining, at double digit annual rates, in the computer industry. This means that new computer models offered at a given price point are generally of higher quality, offering new features and functionality, compared with models previously sold at that same price. This implies that changes in costs for computer components will trigger quality changes in new computers sold at given price points, in addition to affecting prices for older models with fixed configurations whose component prices have changed.

(g) A new analysis of empirical evidence showing that an ODD was considered a key component of a personal computer by OEMs during the class period, accounting for a relatively large share of a computer's cost, and was therefore an economically worthwhile target for collusion by the defendants.

(h) New hedonic analyses of initial procurement prices by retailers for new pre-configured computer models. Controlling for variation in computer characteristics across these new computer models, these hedonic models show that pass-through of component costs into the "baked in" initial price for a new pre-configured computer model can be measured. This analysis is

performed on initial sales prices for computer models manufactured by [redacted] and [redacted] and indicates a "baked-in" pass-through of component cost changes into price that is generally close to, or exceeds, 100 percent.

(i) In the case of HP, I was able to perform a new "end-to-end" "baked-in" hedonic pass-through analysis, linking HP manufacturing cost and computer characteristics to initial consumer purchase price at retailer Best Buy. Conceptually, the rate estimated here is the product of the OEM to Best Buy pass-through rate, times the Best Buy to final purchaser pass-through rate. While controlling for computer characteristics, this hedonic study also found "baked-in" pass-through rates close to, or exceeding [redacted] percent.

(j) New hedonic analyses of initial purchaser prices for new pre-configured computer models at retailers. Controlling for variation in computer characteristics across these new computer models, these hedonic models show that pass-through of procurement cost into the "baked in" initial purchaser price for a new pre-configured computer model can be measured. This analysis is performed on initial sales prices for computer models sold by retailers Best Buy, PC Connection, and MEI, and indicates a "baked-in" pass-through of cost changes into price that is generally close to, or exceeds, [redacted] percent.

(k) An update of my analysis of the response of Dell configure-to-order (CTO) computer prices in changes in component costs utilizing substantial new data that became available after my previous reply report. This analysis continues to be feasible, and to show pass-through of continuing changes in costs into direct retail prices for CTO computers to consumers that are generally near, or exceed, [redacted] percent.

(l) A new study of the effect of continuing procurement cost changes on end purchaser prices for existing models of pre-configure computers sold by distributor Synnex. Pass-through rates of continuing cost changes at Synnex are similar to those found in previous studies of retailers and distributors, i.e., near or exceeding [redacted] percent.

(m) A new study of possible "thresholds" in the effect of cost changes on pass-through of changes in computer cost to retailer pricing to consumers. Utilizing data from [redacted] I statistically test and reject Dr. Burtis' claim that $5 or less cost changes may have a different pass-

through rate than cost changes of greater than $5. In this study also I further test and reject a more general claim that I understand defendants (though not their economic experts) have made—that with small cost changes, there may be no pass-through. My study measures pass-through rates above and below a wide range of cost change thresholds and finds pass-through rates near or exceeding 100 percent above and below all thresholds.

(n) A new statistical study utilizing quantile regression methods that determines whether pass-through of continuing cost changes into price for very expensive computers sold at high prices is likely to be very different from pass-through of continuing cost into price for inexpensive computers. This quantile regression study, using [redacted] data, determines that estimated pass-through rates for desktop and laptop computers at both high and low price points in all cases exceed 100 percent, and in almost cases are statistically significant.

(o) A new summary of all the above pass-through studies, old and new, that demonstrate a consistent, pervasive pattern of estimated pass-through rates near or exceeding 100 percent, from OEMs to distributors, and through all retail and distributor sales channels.

IV. DISCUSSION

A. Additional Analysis and Testimony Regarding Market-Wide Impact on Direct Purchasers of Defendants' Conspiracy

6. I have reviewed this Court's order of October 3, 2014, which finds the economic evidence offered in my June 24, 2013 initial report, and my reply report of February 18, 2014, to not "answer" whether the collusive activity I analyzed in these reports would cause market-wide impact. The Court's order appeared to be based on two main findings regarding my empirical analysis of overcharges. First, the Court found that the analysis I offered was simply a more "complex" version of the analysis offered by Dr. French on behalf of the DPPs.

7. The Court rightly observed that it might be possible to incorrectly ascribe a common correlation between two prices series to an underlying relationship between the two prices when in fact this correlation reflected only the fact that both series tended to decline over time. In fact, the more "complex" statistical tests I carried out, analyses which were ***not*** performed by Dr. French, specifically test whether the apparent co-movement of these different prices could have been

produced by the coincidence of unrelated movements over time, or instead reflects a structural economic relationship between the prices. The tests I initially conducted, extended below with further analysis, provide unequivocal evidence that structural economic linkages bond these prices together cohesively, as economic theory predicts they should, through the workings of competitive market forces.

8. For a commodity electronic component, like ODDs, produced by multiple producers and sold to multiple customers, the economics of marketplace competition transmit changes in price for one producer's products to other producers' products, and across customers. These competitive market forces linking prices together include substitution in both supply and demand, across both producers and customers, as computer maker customers search across producers and drive types for the most cost effective ODD solutions for the computers they build, while ODD producers try to balance their production across drive types, and win market share and customers away from their competitors, in their quest to maximize the profitability of their businesses.[1] Economic equilibrium relationships are observed among ODD prices over time, as is predicted by economic theory. Both an analysis of observed empirical data, and the views of market participants, as documented in communications of the Defendants among themselves, and with their customers, confirm that these cohesive relationships exist. *See* section IV.A.1-3, *infra*.

9. Second, the Court concluded that my overcharge model produced "aggregate estimates for all purchasers purchasing ODDs of particular types in given years". Based on this, the

[1] Purchaser and Defendant documents make the point that ODDs ar dity, [redacted]

In this respect, ODDs are also different from the GPUs described in *In re Graphics Processing Units Antitrust Litigation*, 253 F.R.D. 478 (N.D. Cal. 2008), cited by the Court. This same Dell document notes that graphics cards are not really pure commodities in the same way as ODDs (because of distinctions based on brand and technical features) and therefore unlike ODDs. *See* DELL-ODD00199853 at 9. The operating specifications for various types of ODDs are set out by industry standards consortia, and optical media to be read and written to by ODD drives are guaranteed to be usable on all drives meeting the industry standards for that media; no such common specifications and general guarantees apply to software and hardware used with advanced features of GPUs made by different manufacturers.

court concluded that my overcharge model "assumes" class-wide impact. In this report, I provide further analysis and examples that show how the framework of the model I used in my previous reports can easily be extended to an even more disaggregated analysis, with estimated impacts permitted to vary within the class, and over the class period, in order to test for class-wide impact over purchasers and time periods, in a flexible way. *See* section IV.A.4, *infra*.

1. A Cointegration Analysis Studying Prices for Different ODDs Sold to Different Customer Segments Confirms Market-Wide Impact to Direct Purchasers

10. Economics teaches that changes in price for products viewed as substitutable in demand (by buyers) or production (by sellers), will affect the demand for, and prices of, substitute products. In my initial and reply reports, I reviewed an extensive body of documentary evidence including communications among the defendants and between defendants and buyers, submissions by the defendants to government authorities (like the European Commission), findings of government authorities (like the Taiwanese Fair Trade Commissions) and technical and economic studies of the ODD industry, that establish that substitution in demand and supply for ODDs across producers and customers is viewed as substantial and significant within the industry.[2] This is unsurprising given that ODDs have been characterized by both sellers (including several of the defendants in statements to governments and regulatory authorities) and buyers as a "commodity" product. Indeed, all ODDs license standardized, common technologies from industry patent pools (in which the defendants participate), further underlining the fact that these drives are a commodity product making use of a common technological specification available to firms willing to pay the

[2] *See* Flamm I, ¶¶ 60-80; Flamm II, ¶¶ 6-7.

See also In re the Matter of Sony Optiarc Inc.'s Violation of the Fair Trade Act, (May 16, 2013) (Taiwanese Fair Trade Commission finding that "For computer manufacturers, end-users or ODD manufacturers, there's a high degree of substitution between different types of ODDs and as such, they should undoubtedly be classified as the same-product market.") (Exhibit 137 to the Declaration of Jeff D. Friedman in Further Support of Indirect Purchaser Plaintiffs' Motion for Class Certification ("Friedman II") (dated February 18, 2014); *In re the Matter of Toshiba Samsung Storage Technology Korea Corporation's Violation of the Fair Trade Act* (May 20, 2013) (making same findings regarding substitution of ODDs) (Exhibit 138 to Friedman II).

standard license fees to license and utilize the technology, or if the firm (or a joint venture in which it participates) has contributed essential patents to the pools, as a member of a patent pool.[3]

11. My original analysis (which utilized data for PLDS and TSST) has now been expanded to include data from firms responsible for over 86 percent of the ODD market, including data from the following defendants: BenQ, Hitachi, HLDS, LG Electronics, Lite-On, NEC, Panasonic, Philips, Pioneer, PLDS, Quanta, Samsung, Toshiba, and TSST. This expanded dataset includes all complete transactional data for this expanded set of producers, for all drive types in the redefined class.[4]

12. I originally empirically verified the existence of market-wide impact by performing a study of cointegration among prices for different ODD types sold by PLDS and TSST to different customer segments across the ODD market. The cointegration analysis tested for the existence of stable economic relationships among prices for different types of drives sold to different customers. I found these relationships to exist. **Figure 1** replicates the analysis found in my original and reply reports using this new, expanded dataset, and conclusively establishes the connectedness of the ODD market:[5]

[3] See K. Flamm, "A Tale of Two Standards: Patent Pools and Innovation in the Optical Disk Drive Industry," NBER Working Paper No. 18931, (Cambridge: National Bureau of Economic Research) March 2013, available at http://www.nber.org/papers/w18931 .

[4] Complete transactional data includes all transactions that have a price, a cost measure, and a ship to location, and which could therefore be put through the data quality screens and used with the overcharge model.

[5] *See* Flamm I, ¶¶ 155-173, Ex. 11; Flamm II, ¶¶ 33-35, 54-57, 82-96.

Figure 1: Tests for Cointegration of ODD Type Price Indexes

	Price Indexes		Lag [1]	Correlation	Tests for Cointegration (Number of Cointegrating Equations) Trace (95%) [2]	Trace (99%) [2]	SBIC [3]	HQIC [4]	N
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1.	DVDROM	Combo	1	0.984	-	1	1	1	93
2.	DVDRW	Combo	12	0.983	-	-	1	1	80
3.	DVDROM	DVDRW	10	0.936	-	-	1	1	95

[1] Lag selected based on "consensus" across different lag-order selection statistics (LR, FPE, AIC, HQIC, and SBIC) from vector autoregression model. In the event of a tie amongst the lag selection criteria, HQIC and SBIC are used due to their theoretical superiority. See Lütkepohl, H., *New Introduction to Multiple Time Series Analysis,* New York: Springer, (2005) pp. 148-152.

[2] Number of cointegrating equations chosen using Johansen's trace statistic reported at 95 and 99 percent confidence, respectively.

[3] Number of cointegrating equations chosen by minimizing SBIC.

[4] Number of cointegrating equations chosen by minimizing HQIC.

Note: "-" indicates that the two series are stationary. All possible combinations of stationary or cointegrated variables shown.

Source: Cointegration—drivetype.do

13. My original analysis has also now been extended to test for the existence of a cohesive economic relationship between prices paid by one set of customers (Dell and HP) and prices paid by other purchasers, using all complete transactional data.[6] In these new cointegration analyses, I find strong evidence of equilibrium relationships between prices paid by these customer groups for particular types of drives, as well as replicating my original findings—of equilibrium relationships between prices for different types of drives—using the expanded transactional dataset I have now created. **Figure 2** confirms the market linkages across ODD types and customers:

[6] Prices, by drive type, were measured by Fisher ideal price indexes that I constructed from the expanded transactional dataset. Note that I also used a more flexible specification of possible deterministic time trends in the new cointegration analysis, compared with the specification used in my original report.

Figure 2: Tests for Cointegration of Price Indexes for Dell/HP and Other ODD Customers by ODD Type

	Price Indexes				Tests for Cointegration				
	Dell and HP	Other Customers	Lag [1]	Correlation	Trace (95%) [2]	Trace (99%) [2]	SBIC [3]	HQIC [4]	N
					(Number of Cointegrating Equations)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1.	Combo	Combo	4	0.988	-	0	1	1	83
2.	DVDROM	Combo	1	0.953	1	1	1	1	86
3.	DVDRW	Combo	4	0.991	1	1	1	1	75
4.	DVDROM	DVDROM	1	0.978	-	1	1	1	106
5.	DVDRW	DVDROM	1	0.975	-	-	1	1	98
6.	Combo	DVDRW	11	0.950	1	1	1	1	74
7.	DVDROM	DVDRW	12	0.849	1	1	1	1	93
8.	DVDRW	DVDRW	12	0.952	-	-	1	1	87

[1] Lag selected based on "consensus" across different lag-order selection statistics (LR, FPE, AIC, HQIC, and SBIC) from vector autoregression model. In the event of a tie amongst the lag selection criteria, HQIC and SBIC are used due to their theoretical superiority. See Lütkepohl, H., *New Introduction to Multiple Time Series Analysis,* New York: Springer, (2005) pp. 148-152.

[2] Number of cointegrating equations chosen using Johansen's trace statistic reported at 95 and 99 percent confidence, respectively.

[3] Number of cointegrating equations chosen by minimizing SBIC.

[4] Number of cointegrating equations chosen by minimizing HQIC.

Note: "-" indicates that the two series are stationary. All possible combinations of stationary or cointegrated variables shown.

Source: Cointegration--DELLHP_OTHER.do

14. It is important to note that my cointegration analysis establishes that these relationships among prices for different ODD types and customers are **NOT** a spurious artifact of these prices simply declining over time (as might be the case, for example, with a simple correlation coefficient). Cointegration is a much stronger concept than correlation: Johansen, the developer of one of the cointegration tests used in this report, points out that "…a shock to one [cointegrated] variable implies a shock to all [other cointegrated] variables in the long run..."[7] Testing for cointegration between two prices basically tests that the movement of the two prices with a trend over time is either approximately or roughly parallel, or mirror images, i.e., that as one price experiences an upward blip or deviation from the general long run downward trend, the other too must generally experience either an approximately parallel blip, or alternatively, that as one blips

[7] S. Johansen, *Likelihood-Based Inference in Cointegrated Vector Autoregressive Models*, (Oxford: Oxford University Press), 2009, p. 50.

up, the other tends to dip down, in a mirror image. Similarly, as one price experiences a greater than average downward dip, the other price must roughly experience either a parallel, or mirror-image and opposite, movement over time.

15. Thus, the wiggles and waggles around some downward trend must be roughly connected together in order to find cointegration in the two series. As econometrician Herman Bierens explains, the most commonly found empirical scenario for cointegrated economic variables is parallel movement over time: "For bivariate economic I(1) processes, cointegration often manifests itself by more or less parallel shapes of the plots of the two series involved."[8]

16. Note that two economic variables that are correlated because of the fact of a common decline over time, but do not exhibit either these roughly parallel or mirror image movements as they decline, can be correlated, but will **NOT** be cointegrated. This situation is called "spurious correlation", because a statistically significant correlation coefficient does NOT establish that the relationship in movements over time is caused by a genuine economic equilibrium relationship between the two variables. Instead, a cointegration analysis must be performed to test whether a genuine economic relationship links the movements of the two variables over time. In this sense, a cointegration test is a test for structural economic cohesion among variables with time trends.

17. Cointegration tests were performed in my initial and reply reports, and confirmed that prices for different ODD drives are cointegrated.[9] My new results show that prices for different customer groups are also cointegrated, and thus continue to verify the predictions of economic theory and the documentary record—that the economic forces of substitution in supply and demand link prices for different drives to different customers together in the market. Thus, it is important to recognize that the additional "complexity" of this analysis addresses precisely the issue that both

[8] H.J. Bierens, "Cointegration Analysis," April 2010, *available at* http://grizzly.la.psu.edu/~hbierens/COINT.PDF , p. 1. Note that this paper is an updated and extended version of "Cointegration Analysis", in C. Heij, J.M. Schumacher, B. Hanzon and C. Praagman (Eds.), *System Dynamics in Economic and Financial Models*, (John Wiley, 1997) 217-246.

[9] In some cases, some of the tests may suggest that prices are stationary, rather than being cointegrated. However, this is not an issue. Variables must be non-stationary (i.e., have random trends) in order to be cointegrated. With stationary variables that have no apparent trend over time, however, there is no problem of "spurious correlation" in interpreting correlation coefficients as a valid measure of association between two variables.

defendant experts and the Court raised, that correlation by itself could be a spurious indicator of a market wide impact in the presence of declines over time for any two prices. **The cointegration analysis establishes that these comovements are tightly linked and are not a spurious artifact of coincidental decline over time**. This, in my view, addresses the Court's concern.

2. Additional Analyses, in the Form of a Granger Causality Analysis, Confirm that Changes in Prices of ODDs Sold to Dell and HP Caused Changes in Market Prices to Other Customers

18. While my cointegration analysis establishes that correlations amongst prices for different products sold to different customers are not spurious, and are not simply produced by the fact of these prices merely declining over time, as prices clearly do in this industry, I understand that the Court has expressed concerns that common economic factors other than substitution across the products made by different producers on the supply side, and substitution among products purchased by different customers, on the demand side, and could explain the apparent economic equilibrium comovement of these various prices. In responding to this concern, I note that one major factor that economic theory also predicts will affect prices is costs—indeed the relationship between cost and prices predicted by economic theory is the basis for the prediction of well-established economic theory (and a large empirical economics literature) that cost changes will get "passed-through" into prices.

19. So it would be correct to argue that common shifts or trends in costs for different products might, in principle, also be expected to create an economic relationship between, and common comovement among, observed prices, even if the forces of economic substitution in supply and demand were not already reasons for their apparent observed economic cohesion. ***As a further test*** of the conclusions of the cointegration analysis, I therefore have tested whether changes in one product's market price or cost caused changes in another market price after controlling for the other product's history of both prices and costs, in addition to accounting for potential trends over time. To do so, I employed the concept of ***Granger causality***.

20. Granger causality is a statistical framework that allows inferences to be made on whether or not one variable causes another in a statistical sense. It determines whether past and current realizations of prices or costs have explanatory power in predicting a given price after

controlling for other relevant variables. Nobel prize winner Clive Granger explained the idea of Granger causality as follows:

> [Nobel Physics prize winner Dennis Gabor] told me to read a paper by the eminent mathematician Norbert Wiener which contained a definition that I might want to consider. It was essentially this definition, somewhat refined and rounded out, that I discussed, together with proposed tests in the mid 1960's. The statement about causality has just two components: 1. The cause occurs before the effect; and 2. The cause contains information about the effect that that is unique, and is in no other variable. A consequence of these statements is that the causal variable can help forecast the effect variable after other data has first been used.[10]

21. **Figure 3** presents the results of a Granger causality analysis (one of the fundamental advances which won Granger a Nobel Prize in economics in 2003) and shows that typically the prices of ODD types sold to different customer segments are causally related to prices of ODDs sold to other customer segments, even after controlling for any possible relationship with costs.[11] After controlling for the entire past history of prices and costs for any single type of drive, as well as the cost of those same types of drives sold to Dell and HP, I find that past history of drive prices for Dell and HP still has statistically significant value in predicting current "other customer" drive prices, implying that Dell and HP drive prices cause other customer drive prices, using the statistical definition proposed by Granger and now widely used by economists, other social scientists, statisticians, and even medical and biomedical researchers.[12] This test for causality is very general, and can be applied to both variables with time trends, as well as variables that are stationary and

[10] C.W. J. Granger, "Time Series Analysis, Cointegration, and Applications," Nobel Prize Lecture, December 2003, *available at* http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/2003/granger-lecture.pdf.

[11] The test was performed in a vector autoregressive (VAR) framework allowing costs and ODD prices to vary by drive type and customer. An additional lag was used to allow for the test of Granger causality. Fisher Ideal indexes of Dell/HP and "other customer" prices and costs were constructed and used in this analysis. Details of the statistical procedure can be found in Toda, H. Y and T. Yamamoto, "Statistical inferences in vector autoregressions with possibly integrated processes," *Journal of Econometrics*, 66, (1995) 225-250.

[12] See S.L. Bressler and A.K. Seth, "Wiener–Granger Causality: A well established methodology," *Neuroimage*, Sep 15 2011, vol. 58, no. 2, pp. 323-9. For an elementary introduction, with useful examples of the application of Granger causality in economics, see D.N. Gujarati, *Basic Econometrics*, 4th Edition, 2004, pp. 696-702.

lack time trends.[13] Causal relationships are found between Dell and HP drive prices, and other customer drive prices, for all drive types:

Figure 3: Granger Causality Tests Show Costs Are Not the Sole Determinant of Prices

	P-values for Granger Causality of the Other Customers Price Index, by Drive Type		
	Dell/HP Price Index	Dell/HP Cost Index	Other Customers Cost Index
Combo	0.000	0.000	0.000
DVDROM	0.034	0.000	0.004
DVDRW	0.001	0.363	0.055

Source: granger_causality_DellHP_Others.do

Note: Results for each of the three "Other" customers ODD types based on estimating a single model with the price index for "Other" customers, the price index for Dell and HP, the cost index for Dell and HP, and cost index for other customers. The null hypothesis for the test is Granger noncausality and rejection of the null is evidence of Granger causality. For example, if the p-value were .2 for the Dell/HP price index, then we would fail to reject Granger noncausality at a significance level less than 20%.

22. The upshot of the Granger causality analysis is that prices paid by Dell and HP for ODDs impact the prices charged to other ODD customers. For instance, the p-value of .001 reported for Dell/HP DVD-RW purchase prices in the model for "other customer" DVD-RW prices implies that these other customer prices are causally related to Dell/HP DVD-RW prices, even after accounting for the past history of "other customer" DVD-RW prices and costs, and Dell/HP DVD-RW costs. As explained in the Reference Manual on Scientific Evidence, published by the Federal Judicial Center, a p-value is the "significance level in a statistical test; the probability of getting a test statistic as extreme or more extreme than the observed value. The larger the p-value, the more likely that the null hypothesis is valid."[14]

23. In this same model, we cannot reject the hypothesis that Dell DVD-RW costs do not cause "other customer" DVD-RW prices (with a p-value of .363). For DVD-RWs, then, Dell/HP product prices are an important and statistically significant predictor for DVD-RW prices for other

[13] Toda and Yamamoto, op. cit., describe a method which works with both stationary and non-stationary variables.

[14] Daniel L. Rubinfeld, *Reference Guide on Multiple Regression*, in Reference Manual on Statistical Evidence 354 (3d Ed. 2011)).

customers, while Dell/HP costs are not. Thus, causal relationships exist between Dell, HP, and other customer ODD prices, even after allowing for co-movement related to common costs, and after explicitly eliminating the possibility that the apparent cohesion among the prices reflects instead a spurious correlation among these prices related to common declines over time. (The fact that an underlying economic equilibrium relationship explains the cohesive movement over time was also tested by the cointegration analysis, which eliminated the possibility that trends over time could have created a coincidental, spurious correlation.)

24. To summarize, then, economic theory predicts that demand and supply substitution would create or contribute to a cohesive, cointegrated, equilibrium economic relationship among prices for different ODD types and customer groups. Common costs might be one factor that could create the observed cointegrated, equilibrium economic relationship among ODD prices, but economic theory also predicts that other factors, including demand and supply substitution, would also create or contribute to a cohesive equilibrium economic relationship among prices for different ODD types and customer groups. My analysis of Granger causality shows that even after controlling for potential common costs and trends over time, changes in ODD prices in sales to HP and Dell caused price movements among drives sold to other ODD purchasers, as would be predicted by the economic logic of the demand and supply substitution that I have shown exists in this industry (in previous reports).

3. Defendants Agree that Prices of ODDs Sold to HP and Dell Formed the Benchmark in the Industry, Further Lending Support to the Cohesiveness of the ODD Market

25. I have performed further analysis which confirms that Dell and HP sales created a benchmark floor for prices in the industry.[15] **Figure 4** demonstrates this point:

[15] [redacted] Opposition to Class Certification ("Ordover Report") (dated Oct. 21, 2013), ¶ 94.

Figure 4: Dell and HP Act as a Benchmark Floor for Prices in the Industry

26. **Table 1** further confirms that ***across all customer channels***, other customers paid more for a DVD-ROM half-height drive than did Dell or HP:

Table 1: Share of Customer Transactions at Prices Greater than Dell or HP (2004-2009)

27. Although this Court acknowledged the import of Dell and HP in the market, it expressed its concerns that "the empirical data shows that prices charged to other customers did not cluster within an especially narrow range above the supposed 'floor' of the prices paid by Dell and HP." As demonstrated, however, by the cointegration and Granger causality analysis, these prices too moved in response to price changes for Dell and HP. The fact that there is dispersion for other customers (based on factors such as volume, sales channel, region, or even purely idiosyncratic factors) around a mean price for this group of customers that moves over time in response to changes in Dell and HP pricing does not in any way suggest that these customers were unaffected by explicit price-fixing specifically targeting Dell and HP.

28. I noted in my previous report[16] that even in the most homogeneous, and near-textbook perfect examples of competitive real world markets, there is always some dispersion of prices by customer, around the market mean. Indeed, all measurements of "competitive market price" for even these most homogeneous of real world product markets (e.g., wheat, oil) are simply the mean of observed transactional prices across a group of customers defined over some period of time and set of locations in space.[17]

29. In the *but-for* world, by assumption, the same factors (volume, sales channel, region) and even purely idiosyncratic random deviations from the average market price facing these customers as a group would still be observed, yet price to all would rise because the market price for these "other" customers as a group would still be higher. Any systematic or purely random deviations from the real world market average for the "other customer" group would still be observed, but represent displacements from a lower overall average in the *but-for* world, and hence price for all would be lower by virtue of the lower *but-for* mean relative to which each customer's price would have been positioned. My reply report contained a figure which made this point graphically, by considering the dispersion of prices observed at two retail stores.

[16] Flamm I, ¶¶ 81-105; Flamm II, ¶¶ 5-19.

[17] *Ibid.*

30. In **Figure 5**, the solid lines for each store represent mean price for transactions at that store, the dotted line is the mean price for the local market as a whole. Orange represents the actual observed world, green the *but-for* collusion-free world:[18]

Figure 5: Idiosyncratic Deviations from Statistically Modelled Conditional Mean Prices Are Maintained in the *But-For* World Construct

31. In each store, there is a shelf list price, a business club price, and price match price (based perhaps on a match to an online retailer). Observed prices can be regarded as drawn randomly from one of these customer transactional populations (the figure as drawn suggests that draws from each of these subpopulations are equally likely). If the effect of the collusion is to raise the market price (the average for both of these retail outlets), then removing the collusion will lower both the market average price, and the store average price at each of two stores, as well as each of the individual transactional prices (since idiosyncratic factors that led to deviations from the store average are maintained as actually observed in the real world, in the hypothetical *but-for* world we are asked to consider in estimating damages).

[18] Flamm II, ¶ 11 (Figure 1, Idiosyncratic Deviations from Statistically Modelled Conditional Mean Prices Are Maintained in the "But For World" Construct).

32. Thus, if Bill Gates gets a better deal than a Buddhist monk at a Seattle Best Buy when he checks out at the cash register (a rather unrealistic scenario that I understand came up in argument before the court) in the real world, he still gets the same discount in the *but-for* world, but from a lower, non-collusive market price at the local Best Buy. The only change required in my diagram is to re-label the "price match" as "Bill Gates price" (or add a new and lower—or higher—"Bill Gates price"). As I concluded in my reply report, "diversity in price, variation in price across transaction, is not an obstacle to modeling the impact of collusion on prices for all transactions." The same conceptual framework applies to each of the markets—retail, distributor, OEM, etc.—being considered here.

4. An Augmented Multivariate Regression Model Also Demonstrates a Market Wide Impact for Nearly All Direct Purchasers

33. The Court concluded that my overcharge model produced "aggregate estimates for all purchasers purchasing ODDs of particular types in given years". Apparently based on this conclusion, the Court stated that my overcharge model "assumes" class-wide impact. In this report, I provide further analysis and examples that show how an even more disaggregated analysis, with estimated impacts permitted to vary within the class, and over the class period, can be implemented, in order to test for class-wide impact over purchasers and time periods, in a flexible way.

a. An Augmented Multivariate Regression Model, Which Allows Variation in Overcharge Rates by Customer Group, Drive Type and Month, Demonstrates Impact on Direct Purchasers of ODDs

34. In my previous reports to this Court, I proposed a preliminary model to measure overcharge. Using data from Lite-on/Philips/PLDS, Quanta, and Hitachi, for DVD-RW, DVD-ROMs and Blu-ray drives, I estimated a reduced form multivariate regression model.[19] The model estimated the economic damages attributable to the alleged conspiracy by looking at prices direct purchasers actually paid and what they would have paid *but-for* the alleged conspiracy. The model uses a non-collusive benchmark period of 2 years and five months (29 months total—July 2009 through December 2011) after the class period to compare the prices class members paid during the class period to those prices outside the period.

[19] Flamm I, ¶¶ 186-223; Flamm II, ¶¶ 131-134.

35. The model included multiple independent variables to control for non-collusive economic factors that normally influence price (such as factors that shift demand, and declining costs), and includes an annual "dummy" indicator variable for each type of ODD (which in the redefined class would now be changed to DVD-RW, DVD-ROM, and COMBO drives) which is the independent variable that determines the baseline annual impact of collusion on price, and which can be used to test whether the alleged conspiracy influenced price. In addition, I included "traffic" variables, measuring the type and intensity of defendants' direct communications with one another, as a determinant of the collusive impact (since, based on economic theory, empirical economic studies, and empirical economic experiments, direct communications among participants have been established to affect collusive impact).[20] The net result was an estimated impact on price, and estimated overcharge rate, that varied with ODD type, monthly intensity of various categories of direct communications among participants, and year, over the collusive period.

36. To control for unmeasured model-specific characteristics that might be correlated with the other explanatory variables, I used a so-called "fixed effects" statistical model. In effect, every drive model's price tracks in a specific way the overall price trends caused by the time-varying variables whose effects are being measured.

37. The model also includes numerous variables that control for economic factors that might explain changes in price during the class period, including controls for:

- the bill of material and manufacturing costs for each type of ODD;
- the number of sellers for each type of ODD;
- the number of units sold of desktop and laptop personal computers;
- the average transaction size for each type of ODD;
- Other microeconomic market variables with impacts specific to each drive type, such as a flash memory price index, the U.S. Producer Price Indexes for all computer products, portable computers, and non-portable computers; the U.S. Consumer Price Indexes for software, internet services, and personal computers;
- Thirty-seven "macro-economic" variables common to all products to control for general economic conditions, including industrial production for eight countries,

[20] Flamm I, ¶¶ 91-105.

unemployment rates for six countries, exchange rates for seven countries (counting the Euro currency area as one country for the purposes of this analysis), consumer price indices for eight countries, and producer price indices for eight countries;

- Twelve traffic variables measuring the volume of defendants' communications (specifying whether the communications reflect an explicit agreement on price, implicit agreement, or the content of the conversation was unknown) in documents produced in this litigation; and

- I have now extended this model by allowing the overcharge to vary by customer group and ODD drive type, over time.

38. Whereas in my original report, I included a graphical example of the variation in overcharge rates by customer group and drive type,[21] I now provide further demonstrations of the flexibility of the overcharge model. The results show that statistically significant overcharges are generally found for Dell and HP, and "other customer" groups. Note that these overcharge rates now vary by month, drive type, and buyer group, and allow for pricing differences across ODD producer, buyer, ODD model, and geographic region.

39. **Table 2** shows show how overcharge rates that vary by customer group and drive type are easily incorporated into the modeling framework I introduced in my earlier reports:

[21] *See, e.g.*, Flamm II, Figure 4.

Table 2: Overcharge Coefficients for Dell-HP and Other Customers by ODD Type

Overcharge Coefficient	Dell-HP	Other
DVDRW_2003	0.235**	0.243**
DVDRW_2004	0.210***	0.231***
DVDRW_2005	0.210***	0.252***
DVDRW_2006	0.144***	0.187***
DVDRW_2007	0.091**	0.174***
DVDRW_2008	0.049*	0.094**
DVDRW_2009	0.018	0.053**
DVDROM_2003	0.188**	0.260***
DVDROM_2004	0.167**	0.232***
DVDROM_2005	0.157***	0.216***
DVDROM_2006	0.097**	0.156***
DVDROM_2007	0.052	0.125***
DVDROM_2008	0.039	0.098***
DVDROM_2009	0.010	0.032
Combo_2003	0.174**	0.200**
Combo_2004	0.171**	0.175**
Combo_2005	0.164***	0.129**
Combo_2006	0.133***	0.088*
Combo_2007	0.080**	0.050
Combo_2008	0.035	0.023
Combo_2009	0.012	-0.007

N = 14,439
note: *** p<0.01, ** p<0.05, * p<0.1

The preliminary results from implementing this model indicate, with very strong statistical significance, that between 2003 and 2008, purchasers of ODDs were affected by inflated prices, and high overcharges.

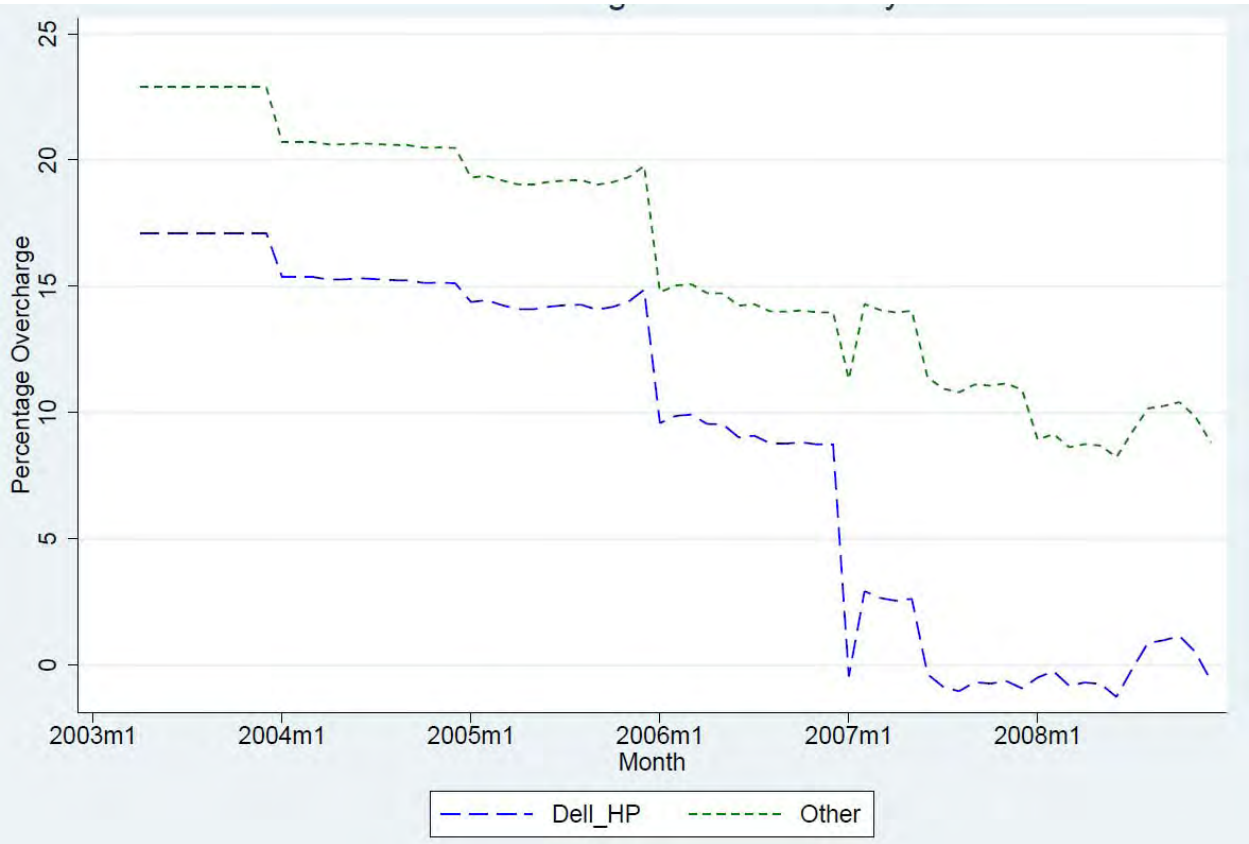
40. **Figure 6** is a graphical depiction of the variation in overcharge rates on DVD-RWs by customer group, drive type and month:

Figure 6: Overcharge on DVD-RWs by Month and Customer Type

Again using the results from the exemplary overcharge model I have proposed, this figure shows the time pattern of the overcharges imposed on DVD-RW customers, and how the overcharges on Dell and HP were substantial, but less than those for those imposed on other customers.

41. I produce a similar graphical depiction demonstrating the overcharge for DVD-ROM drives in **Figure 7**:

Figure 7: Overcharge on DVD-ROMs by Month and Customer Type



42. And, again, **Figure 8** depicts the monthly overcharge for COMBO drives. In this case, Dell and HP seem to have had higher overcharge rates after 2005, possibly because these were legacy products purchased by them in relatively small volumes during the latter part of the class period:

Figure 8: Overcharge for COMBO by Month and Customer Type

43. An exemplary summary of damages to the indirect purchaser class can be found at **Exhibit 3.**

b. The Multivariate Regression Now Incorporates Data From Producers Who Collectively Accounted for Over 86 Percent of the ODD Market

44. In its October 2014 Order, the Court expressed concerns that the overcharge model only looked at specific, selective examples. Given limits to time and resources (and late production of data for some Defendants) available for the analysis undertaken in my initial reports, my goal was primarily to demonstrate a methodology that could be applied to additional data as it became available. I can now report that the model continues to work well, and produce reasonable results, after further incorporating transactional sales and cost data for drives sold by BenQ, NEC, Panasonic, Pioneer, Samsung, Toshiba, and TSST, in addition to the data from Philips/Lite-On/PLDS, HLDS, and Quanta used in my earlier reports. The overcharge model now utilizes 2.4 million observations and covers firms accounting for 86 percent of sales in the ODD market.

45. Only two defendants' data—Sony and Teac—have not been utilized in the overcharge model. This is because Sony and TEAC have not provided data for monthly costs of manufacturing for each model in their sales data production. Should Sony and TEAC provide usable data in the future, this model could be augmented with their data as well.

46. Because the defendant companies provided their ODD cost data in widely varying and sometimes inconsistent formats, substantial work went into creating manufacturing cost measures that were comparable across defendant ODD producers. Even after all this effort, the resulting cost measures are probably best interpreted as "proxy" variables for a true, unobserved incremental cost of producing an additional ODD at any defendant company. As is well understood in econometrics, "[l]oosely speaking, a proxy variable is something that is related to the unobserved variable that we would like to control for in our analysis."[22] Since the accounting cost systems and concepts found in defendant-produced data vary widely across defendants, there is good reason to believe that the relationship between our proxy cost variable and the unobserved incremental cost of manufacturing an ODD also varies across defendants. Consequently, the coefficients of all variables containing defendant manufacturing cost, or other variables that interact with defendant manufacturing cost, varied by producer in my regression model using the augmented defendant production and cost data.[23]

[22] J. M. Wooldridge, *Introductory Econometrics: A Modern Approach*, 5th Edition, (Mason, OH: South-Western Cengage), 2013, p. 309. Wooldridge then goes on to give an example of a proxy variable: "In the wage equation, one possibility is to use the intelligence quotient, or IQ, as a proxy for ability. This does not require IQ to be the same thing as ability; what we need is for IQ to be correlated with ability, something we clarify in the following discussion."

[23] In technical terms, we are assuming that for every defendant d, defendant d's unobserved cost C_d is related to my cost proxy variable X_d by a linear relationship $C_d = a_d + b_d X_d + u$, where a_d and b_d are defendant-specific coefficients related to the details of their cost accounting systems, and u is a random statistical discrepancy or disturbance term. As a consequence, the coefficient of variables containing cost or interacting with cost in the regression model will vary by producer, and the estimated coefficients of these variables will incorporate the coefficient b_d of the proxy variable relationship. (Producer-specific intercept term a_d is incorporated into the fixed effect, which is not actually estimated in my fixed effects model.) However, these are not the coefficients of primary interest in our model, and use of a proxy variable to control for cost allows us to correctly estimate the overcharge, the effect of the alleged collusion on price. See Wooldridge, op. cit., p. 310.

c. The Multivariate Regression Model Appropriately Aggregates Data to Increase Statistical Precision, After Appropriate Examination of Market Structure for Sales of ODDs

47. The overcharge model, as perhaps might have been expected, given the greater bargaining power of Dell and HP, confirms that the "other" customer group generally faced higher price elevations than those imposed on Dell and HP, the largest volume buyers, during the collusive period.

48. Note that my methodology does not find statistically significant (at the 10 percent significance level) overcharges for certain ODD types, customers, and time periods. This shows that the methodology is therefore capable of discriminating between time periods, customer types, and products for which statistical evidence provides overwhelming support of impact on class members, and time periods, products, and customers for which the statistical evidence is less unequivocal. It is my understanding, for example, that based on the evidence of this more refined model, plaintiffs have decided to simplify their damage claims by dropping damage claims for 2009—based on the fact that while this model shows damages to the "other customer" purchasers of DVD-RW drives, the evidence for statistically significant injury in Dell and HP purchases is less persuasive, such that we cannot reject the hypothesis that the overcharge to Dell and HP was zero, at the 10 percent significance level.

49. More fundamentally, for a Court finding that "aggregate" results assume rather than demonstrate market-wide impact, there must be some economic basis for different outcomes in the market based on unique features of subgroups participating in a competitive market that affect supply or demand. For example, one might argue that the conduct at issue might limited to some isolated geography, where price-setting or competition are localized, and unaffected by market outcomes in neighboring markets. Or, one might claim that products were so unique and differentiated, that there was little economic substitution possible between products.

50. But Defendants' experts did not provide principled economic reasons, or empirical factual support, or even dispute the weight of the extensive documentary record I reviewed, for any such claims of market isolation. Indeed, Defendants' economic expert implicitly endorsed the view that these ODDs were sold in markets with significant economic linkages across customers and

products, when he argued that the impressive statistical evidence of market cohesion—cointegration and (therefore non-spurious) correlations among ODD prices across various submarkets—could be dismissed as the mere workings of "competitive economic forces"![24] But "competitive economic forces" is just economics shorthand for the idea that substitution between products and producers in supply, and among purchasers in demand, drives transactional prices toward a cohesive competitive market price as an outcome.[25]

51. Instead, Defendant economic experts embarked on a "slice and dice" statistical strategy which relied on chopping the units being analyzed size to such a small sample size, such that estimates of overcharge (or pass-through) coefficients would be overwhelmed by sampling noise, and invalid large-sample approximations inappropriately reported as valid small sample standard errors. I conclusively demonstrated the flaws of this "slice and dice" approach by simulation, in an analysis that went unrefuted and ignored by both Defendants' lawyers and economic experts.[26]

52. As previously remarked, my cointegration and Granger causality analyses provided compelling evidence of economic relationships linking ODD prices across drive types and customers into a cohesive market. Rather than presenting contrary economic reasoning or empirical evidence, Defendants experts have relied exclusively on creating statistically tiny samples, with large consequent sampling noise, in order to produce hyper-noisy statistical estimates with inaccurate estimates of sampling variance, as their sole basis for asserting heterogeneity of impact.

53. If one limits a sample to a sufficiently small size, one can generally produce statistical estimates of regression parameters that are different for different subsamples, even if the underlying data for different sub-groups is generated by a single value for a common parameter. (The statistical property of consistency, discussed in my earlier reply report, demands large samples in order to ensure that estimates are reliable and reasonably close to true values, as does the large sample approximation used to correctly characterize uncertainty about estimated parameters in these

[24] Ordover Report, ¶ 150.

[25] *See* Flamm II, ¶ 84 (textbook definition of competitive market).

[26] *See* Flamm II, ¶¶ 5-38.

regression models.) Thus, by slicing and dicing samples into large numbers of sufficiently small subsets, one is virtually certain to be able to produce spurious and unreliable statistical "evidence" of heterogeneity by simply reducing sample size sufficiently in the proliferating "sliced and diced" groups being compared. Further, estimates of uncertainty (estimated standard errors) in these unreliably estimated parameters are themselves highly unreliable when based on small numbers of observations.

54. Indeed, as an extreme case, absent highly and unrealistically restrictive assumptions, it is not even possible to analyze the effect on an intervention on a single individual's behavior using statistical techniques, in attempting to measure the causal effect of some intervention on individual behavior.[27] The same logic applies even to small groups of random selected individuals; that is, if the groups are not sufficiently large, it is also impossible to reliably test homogeneity in average effect of an intervention across groups using statistical methods.

55. Therefore, conceptually, statistical testing must generally involve statistical comparison of differences in effect among groups that are sufficiently large as to provide valid and reliable statistical estimates. Economic reasoning should provide some principled conceptual guidance for defining a group across which homogeneity of effect is to be tested. If sufficiently large sample sizes exist, then one can draw reliable statistical inference. Defendants' approach turns this on its head, by ignoring the economic reasoning underlying the definition of sub-groups to be compared, and by simply slicing and dicing samples arbitrarily down to a tiny enough size such that random sampling error is guaranteed to overwhelm any but the most extreme differences in outcome for any comparison across groups.

56. In contrast to Defendant's experts "data mining" for small sample sizes sufficient to yield large variation in results driven purely by sampling noise, my overcharge model used

[27] Some modern econometric textbooks even ***define*** a causal effect as a group average, as what one would measure as the average effect of an intervention on the treatment group, when compared with a control group, in a randomized controlled experiment. "In this book, the **causal effect** is defined to be the effect on an outcome of a given action or treatment, as measured in an ideal randomized controlled experiment. In such an experiment, the only systematic reason for differences in outcomes between the treatment and control groups is the treatment itself." J.H. Stock and M.W. Watson, *Introduction to Econometrics*, 2nd Edition, (Boston: Pearson) 2007, p. 9.

principled groupings of products and customers that were found to be related economically to one another by long term economic relationships, based on economic theory, a review of the documentary record, and my cointegration and Granger causality analyses. Further, in the new exemplary analysis shown in **Table 2**, I disaggregate the economic impact of the collusion in my overcharge model across these groups of drive types, customers, and time periods, allowing profit margins, regional and customer pricing differentials, and various microeconomic variables affecting supply and demand for different types of ODDs, to vary in their effect on price across both ODD types and customer groups. If the impacts of these variables is different across drive type and customer groups, my model accounts for this. I continue to find empirical evidence of market-wide impacts on all ODD customers for some time periods, ODD types, and customer groups, just as I find statistically less persuasive evidence of impact for other drive types, customer groups, and time periods. The results of the model are driven by the empirical evidence in the data, allowing us to distinguish between periods, products, and buyers with relatively overwhelming statistical support, from other periods where the statistical evidence is less clear cut.

57. In short, I have now shown explicitly that my overcharge model is capable of estimating how pricing for different customers and ODD drive types is affected by collusion, while allowing different market factors to have different effects on prices for different drive types and customer groupings. The cointegration and Granger causality analyses verified that collusion affecting price formation for one product and customer group would have the impacts on prices for other drive types and customer groups predicted by economic theory. The overcharge model extended in this report allows overcharges for these drive types and customer groups to vary by drive type and group, as well as by month, as well as incorporating data from all defendants providing usable information on their prices and costs.

B. Further Analysis of Pass-through Supports Previous Evidence that Prices for Effectively All ODD Products Would Have Been Affected

58. In its October 2014 Order, this Court expressed concerned that IPPs had not presented a persuasive explanation as to why it would be "reasonable to assume a uniform pass-through rate given that ODDs typically make up a relatively small portion of the cost of the products

into which they are incorporated, and given the existence of price points—i.e., the common practice in the industry of selling products costing in the hundreds of dollars at prices just under the next $100 mark." Order at 21. The Court posed the hypothetical situation where the overcharge paid by a direct purchaser was only $4, and whether it was plausible that the retailer would then raise the price of a computer that otherwise would sell for $999 to $1003.

59. I have performed additional empirical economic analyses that address these concerns.

60. Briefly summarizing, these analyses show that the answer to the Court's question is as follows: if the retailer is selling a pre-configured computer model designed to be sold (initially) at a particular price, a $4 increase in a component cost would result in a change in the but-for world computer model's configuration that would preserve the desired initial $999 price tag, but substitute for it in the actual world a computer that would have been valued in the market for less, at $995, in the but-for world, absent the component price increase. The $4 increase in cost for a "key component," like an ODD, would have triggered a search for cost reductions elsewhere in the computer, and a reduction in the quality of the computer sold in real world for $999, which in the *but-for* world would have been priced at only $995. This amounts to an effective increase in price of $4 for the observed computer in the real world relative to the *but-for* price, when the theoretically appropriate adjustments for diminished computer quality resulting from the collusion-induced overcharge are made. The computer sold for $999 in the but-for world would have contained $4 worth of additional features, with value to consumers, not present in the $999 computer sold in the real world.

61. These substitutions are most plainly and directly evident in sales of configure-to-order computers, where price varies directly with configuration choices explicitly chosen by consumers as they buy their computer (as was true in the Dell direct retail sales transactional data I previously analyzed[28]), and where there is no single fixed price at which a computer is initially sold. But the substitutions also show up—and with them a large and statistically significant link between

[28] *See* Flamm II, ¶¶ 213-220, Pass-Through Exhibit 13.

component cost and initial price point—when initial prices for pre-configured computer models are appropriately analyzed, as I do below.

62. While a particular retailer, say Best Buy, may not have initially sold a particular new computer model at a $995 price point, or a $1005 price point, Dell (after appropriate configuration choices by consumers) almost certainly did sell such configurations directly to consumers, and [redacted].[29] In addition, other retailers and OEMs would be packing just as many desirable features as possible into the computers that they sold in competition with Best Buy's offerings at a $999 price point, attempting to steal market share from Best Buy and its OEM suppliers—because that is the nature of competition in this intensely competitive industry. Any increase in component cost would lead to an industry-wide diminution in the features—i.e., in quality—of a computer model that could be designed by OEM and retailer to sell at a retailer's chosen price point. The reduction in quality at some price point creates an increase in quality-adjusted price for these computers, and therein lies the harm from component price-fixing for a buyer of computers sold by some retailer at some targeted, initial price point. The new studies I have undertaken strongly support this conclusion.

63. Further, a variety of other empirical studies I have conducted, including the multitude of pass-through studies I previously performed in my prior reports, confirm that further cost declines, large and small, that are recorded after first sale, are passed-through into price declines, typically on about a one-for-one basis. Any effect of the alleged collusion in slowing cost declines would also slow further computer price declines for buyers, even after the initial impact on first sales price had been felt.

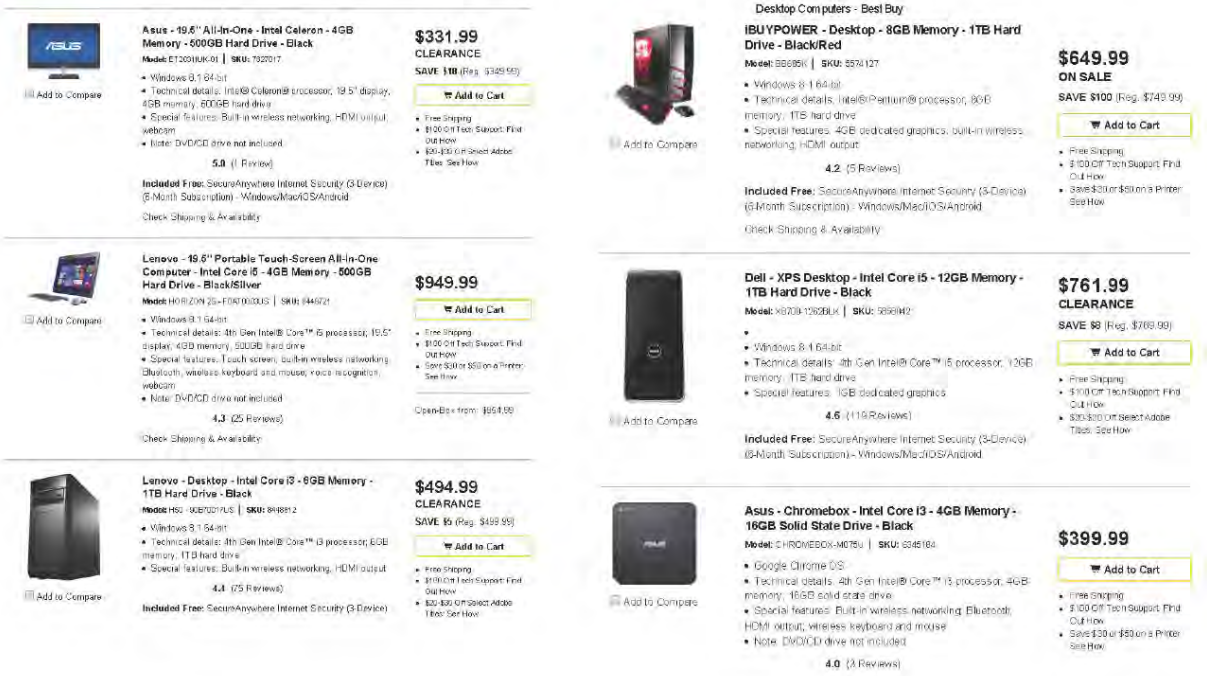
64. I further add to this empirical foundation studies that test whether small (or large) cost changes after a model is first introduced are somehow treated differently by retailers than large (or small) ones. On top of this I add still another empirical economic study that asks the question, are models initially sold at higher prices somehow immune in responding to cost declines, when compared to models sold at cheaper price points? (Answer: no.) Careful study of the empirical

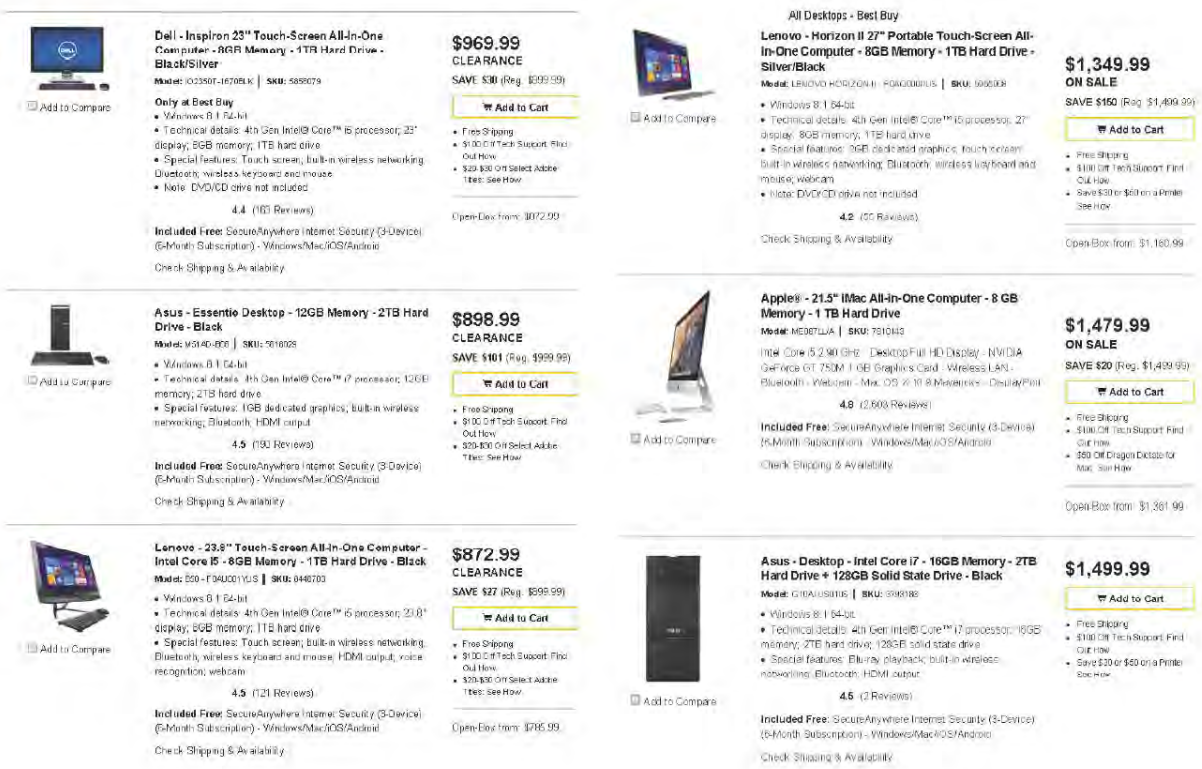
[29] [redacted]

economic evidence overwhelmingly supports the conclusion that cost changes, large and small, are passed through into prices for all kinds of computer models, both pre-configured and configure-to-order, before and after the computer model is first introduced into the market. This is consistent with the nature of a PC marketplace that economists and other analysts familiar with this industry agree has been intensely competitive in recent decades.

65. Finally, a perusal of current advertisements by Best Buy and other retailers make it clear that in practice, even small discounts on high-priced computers are implemented at large retailers in order to boost sales. **Figure 9** shows recent online advertisements by Best Buy of promotional $5 discounts off a $499 computer, $8 off a $769 computer, $27 off an $899 computer, and $20 off a $1499 computer:

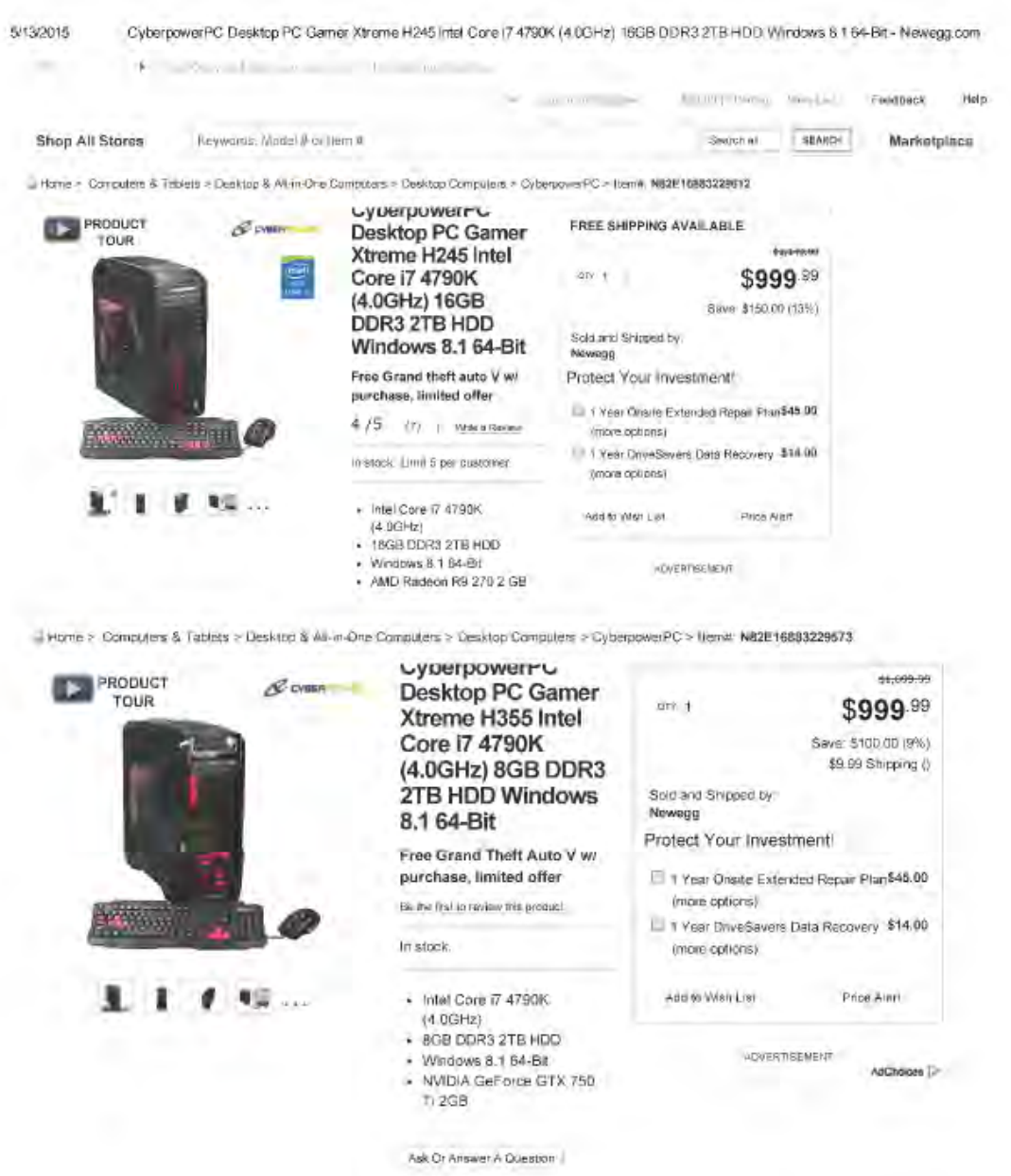
Figure 9: Best Buy Advertised Small Discounts to Promote Sales, May 12, 2015 (Online)

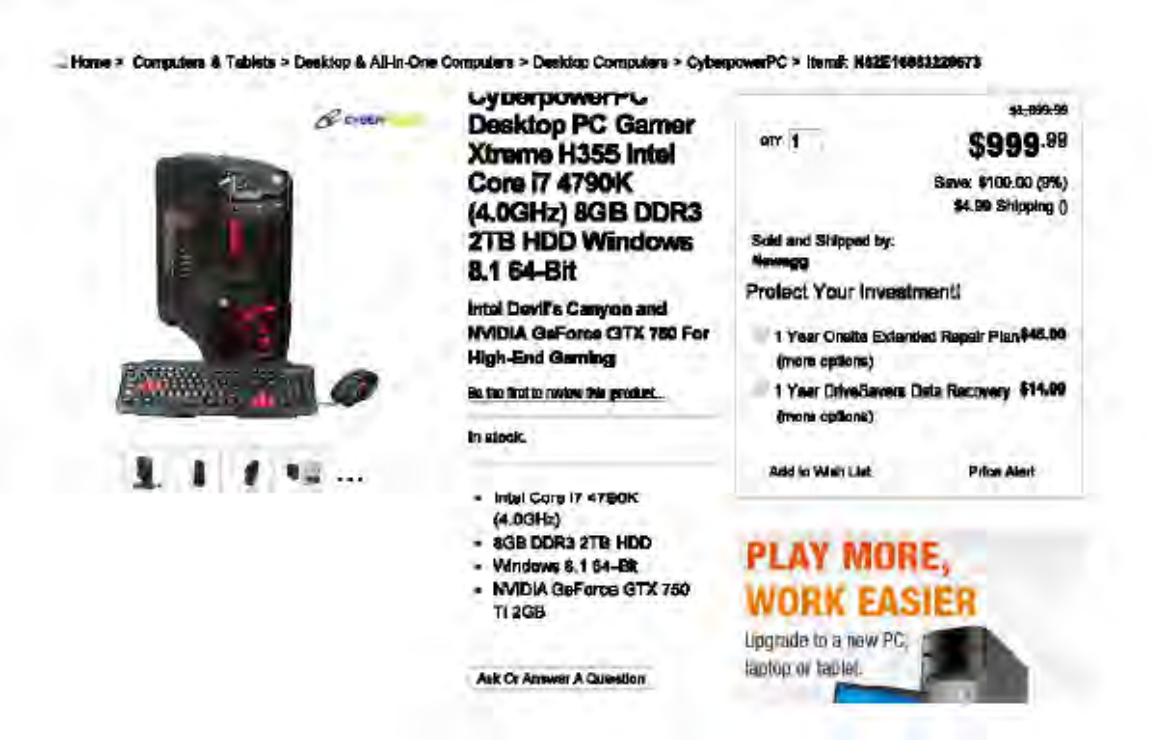




66. Internet retailer Newegg, one of the several retailers that Dr. Burtis identifies as a member of the subset of retailers making most frequent use of $49 and $99 price points, in fact provides easily accessible real world examples that almost precisely match the "implausible" small price adjustments to a $999 computer proposed as a hypothetical counterfactual by the defendants, and effectively misdirected the Court. **Figure 10** shows three high-end (Intel i7 4790K processor) CyberpowerPC-branded computers priced by Newegg at $999.99, one offered with $9.99 shipping, another offered with $4.99 shipping, still another offered with free shipping. Similarly, a high-end Lenovo computer with the same high end Intel processor was offered for $1089 (a $10 reduction from its $1099 list price) and $6.99 shipping. Newegg seems to adopt a highly varied menu of small promotional changes in prices, often in the form of discounts to shipping charges, in its efforts to stimulate sales of the products it offers for sale. The Court's example of a $4 discount or price increase on a $999 computer, far from being implausible, seems to be fairly common at Newegg, and is reflected in the varied menu of small changes in promotional shipping fees offered with the $999 computers it offers for sale:

Figure 10: Shipping Costs at Newegg





67. Newegg clearly must think these small promotional price changes affect its sales to consumers, otherwise, why offer them? And Newegg is clearly cognizant of the impact that even these small discounts have on its bottom line profitability, otherwise, why not offer free shipping on all computers over a certain price? The "implausible" hypothetical small price change on an expensive PC is eminently plausible, and firmly grounded in the real world of retailing practice.

1. Using Evidence Common to the Class, Economic Measurements Demonstrate Overcharge Is Included in All Prices of Computers, Including the Initial Price Point

68. In order to understand how cost changes affect prices, it is important to understand the price-setting process for OEMs manufacturing computers for resale by U.S. retailers. Computer OEMs manufacture both configure-to-order (CTO) and pre-configured, fixed configuration computers. CTO computers are configured directly by consumers and sold directly to them online, or through kiosks at shopping malls or retail stores. Prices for CTO computer models vary directly with the configuration selected by the consumer. (My previous analysis of Dell computer pricing in

my prior reports analyzed pass-through in direct sales by Dell to customers for CTO laptops and desktops.)[30]

69. Pre-configured computers are also sold by retailers, as well as online, directly by OEMs or through online retailers. Pre-configured computers have a fixed model number, or SKU, that uniquely defines the particular computer configuration being sold.

70. Large retailers (for example, Best Buy), negotiate directly with computer OEMs over the details of pre-configured computers given shelf space, and carried in inventory, at their stores and warehouses. Ahead of the next wave of new computer introductions, the retailer confers with the computer OEM and describes what features it would like to offer in a computer sold in a particular "price band" (typically a $30-50 range in which it would like to sell a competitive model computer with those features), and the computer OEM tries to offer configurations that best achieve the retailer's feature preferences while meeting the cost target at which the retailer hopes to acquire the model. The cost target (price to retailer) is designed to allow the retailer to make an adequate profit on the sale,[31] while simultaneously maintaining an adequate profit margin for the OEM on the sale to the retailer. Thus, the OEM has two targets to meet—the retailer's price (the price to final buyers, which builds in an assumed margin for the retailer with respect to the price at which the product is sold to the retailer by the OEM), designed to allow the retailer to make its required profit margin, and the OEM's own internal cost, which needs to be sufficiently low to allow it to make an adequate profit.[32]

---

[30] *See* Flamm I, ¶ 245.

[31] In her Report (¶¶ 98-99), Dr. Burtis observed that the retailer data used in my pass-through analysis show certain products were priced below their recorded cost at certain times. My discussion here does not imply that the every model (or OEM or retailer) must realize a profit, but is a more general description of the ways the OEMs and retailers work toward meeting their fundamental economic objectives of profit maximization. It is also important to point out that the produced product-level Best Buy cost data do not include all cost reductions, price protection adjustments, rebates, and other margin enhancements given by OEMs to Best Buy. This is discussed in greater detail below.

[32] *See, e.g.,*

- [redacted]

[redacted]

71. The retailer wants the best possible combination of features desired by consumers at a price point, generating a high sales volume ("sell through") given the profit margin it desires at that price point. The computer OEM wants the retailer to be able to sell through large volumes as well, and wishes to produce the computer model and sell it to the retailer at a price that guarantees it too an adequate profit margin on the sale to the retailer.[33]

72. [redacted]

[redacted]

[redacted][35].

[35] *See, e.g.,*

- [redacted]

73. New computer models are not just sold at initial dollar prices ending in $49 or $99. A [redacted].[36] Other retailers confirmed that focal point pricing— focusing on ten dollar increments (versus rounding to the nearest dollar)—is not standard industry practice.[37]

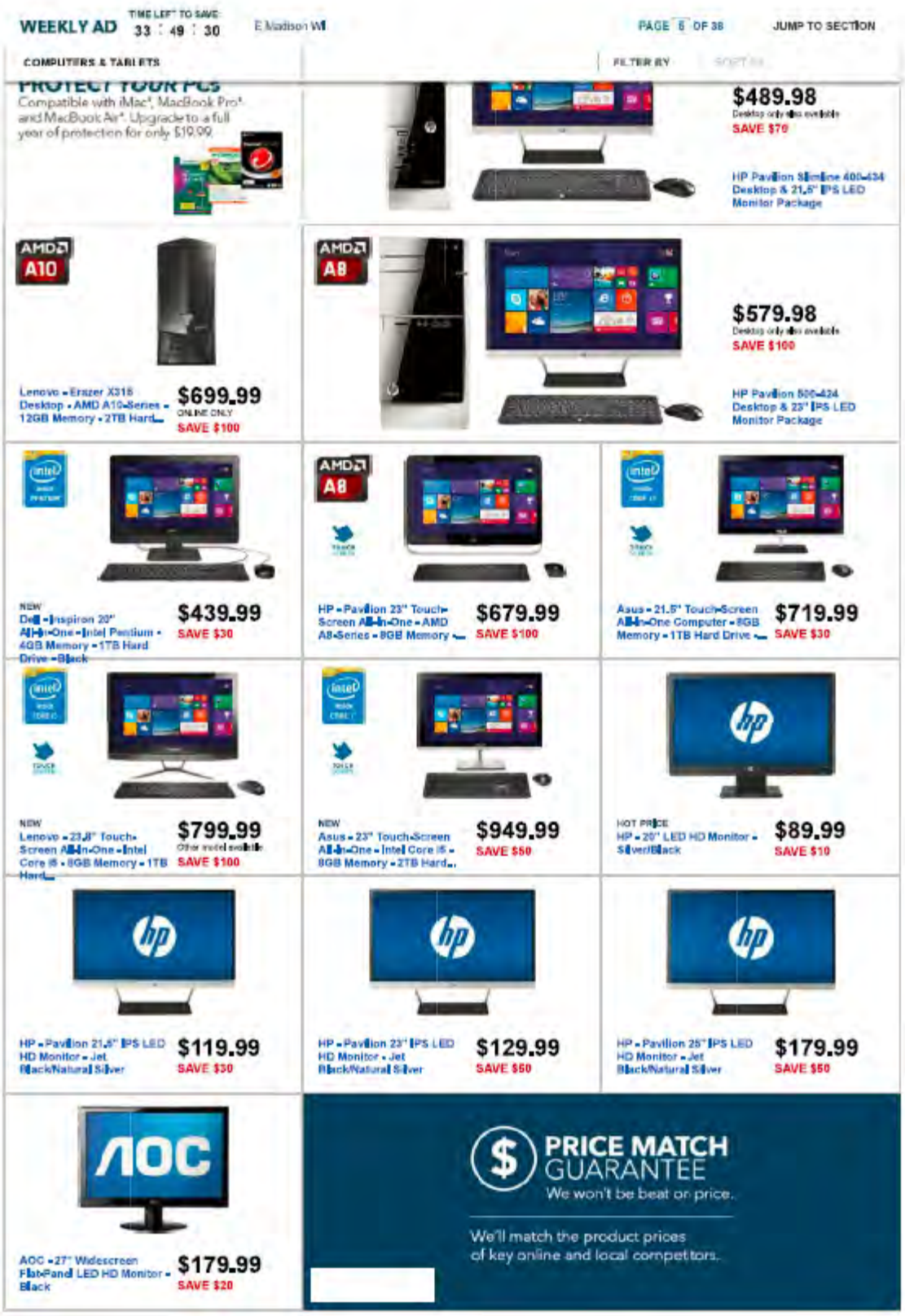
74. And in fact, many different initial sales price points for new computer models are observed in Best Buy data. **Table 3** demonstrates that [redacted]

[redacted]

Table 3: Best Buy Adjusts Prices Frequently, Even in the First 30 Days of Sales, Desktops and Laptops

75. **Figure 11** shows, as an example, the May 10, 2015 Sunday Best Buy ad. The following figure shows Best Buy promoting the sale of 9 notebook computers and 8 desktop computers in its Sunday weekly flyer ads on that day. Of the 17 price points for computers shown, only 7 (41 percent) end in $49 or $99. Price points ending in $19, $29, $39, $59, $79, and $89 account for the majority of advertised prices for the 17 computers featured during this week's promotions. The amount of discount from "normal" computer pricing in these weekly price promotions also ranges widely, over a spectrum from $30 to $130 dollars off:

Figure 11: Best Buy Weekly Advertisement (Online) May 10, 2015 -- Prices Other Than 49 and 99 Price Points


WEEKLY AD
TIME LEFT TO SAVE: 33 : 49 : 30
E Madison WI
PAGE 6 OF 38
JUMP TO SECTION
COMPUTERS & TABLETS
FILTER BY
Compatible with iMac®, MacBook Pro® and MacBook Air®. Upgrade to a full year of protection for only $19.99.
$489.98
SAVE $70
HP Pavilion Slimline 400-434 Desktop & 21.5" IPS LED Monitor Package
AMD A10
Lenovo - Erazer X315 Desktop - AMD A10-Series - 12GB Memory - 2TB Hard...
$699.99
ONLINE ONLY
SAVE $100
AMD A8
$579.98
SAVE $100
HP Pavilion 500-424 Desktop & 23" IPS LED Monitor Package
NEW
Dell - Inspiron 20" All-In-One - Intel Pentium - 4GB Memory - 1TB Hard Drive - Black
$439.99
SAVE $30
AMD A8
HP - Pavilion 23" Touch-Screen All-In-One - AMD A8-Series - 8GB Memory ...
$679.99
SAVE $100
Asus - 21.5" Touch-Screen All-In-One Computer - 8GB Memory - 1TB Hard Drive ...
$719.99
SAVE $30
NEW
Lenovo - 23.8" Touch-Screen All-In-One - Intel Core i5 - 8GB Memory - 1TB Hard...
$799.99
Other model available
SAVE $100
NEW
Asus - 23" Touch-Screen All-In-One - Intel Core i5 - 8GB Memory - 2TB Hard...
$949.99
SAVE $50
HOT PRICE
HP - 20" LED HD Monitor - Silver/Black
$89.99
SAVE $10
HP - Pavilion 21.5" IPS LED HD Monitor - Jet Black/Natural Silver
$119.99
SAVE $30
HP - Pavilion 23" IPS LED HD Monitor - Jet Black/Natural Silver
$129.99
SAVE $50
HP - Pavilion 25" IPS LED HD Monitor - Jet Black/Natural Silver
$179.99
SAVE $50
AOC - 27" Widescreen FlatPanel LED HD Monitor - Black
$179.99
SAVE $20
PRICE MATCH GUARANTEE
We won't be beat on price.
We'll match the product prices of key online and local competitors.

76. Nonetheless, it is true that these two particular price points are more frequently observed than other price points in the data for some retailers (like Best Buy, though not for others), and suggests that these price points (which may also reflect daily or weekly promotional price reductions from other initial price points) may be chosen by top product line sales managers (Best Buy calls theirs 'merchants') more frequently at those particular retailers.

77. The most important point, however, is that configurations of pre-configured computers designed by OEMs to be sold at all price points, including the "49" and "99" price points, are negotiated between retailers and OEMs. Features are added and removed from configurations and models, as suppliers are being pressured to reduce costs, in order to meet price and cost targets for both retailers and OEMs in the design of new computer models. The documentary record in this case (and my previous 35 years of experience studying the computer industry) yields many examples of OEMs pressuring suppliers for small reductions in component prices, and small and large features of computers being altered in order to meet cost and pricing targets.[38] Data produced in this case shows that computer OEMs had many ways of making small alterations in their computer configuration to reduce costs by small amounts, and conversely, that they had many ways in which they could add features to their computers to make them more attractive to consumers for only small increases in cost.

78. For example, Toshiba cost data for 2007 show that its cost of upgrading a laptop from an Intel Pentium T2130 dual core processor (running at a 1.86 Ghz speed) to a superior Intel Core Duo T2450 (running at 2.0Ghz speed, and having double the cache memory) was about $[redacted] The cost of bundling simple DVD writing software with a computer was about $[redacted] Adding a modem and cable (allowing the laptop to communicate via dialup over a telephone line) added [redacted] in cost. Adding an ExpressCard interface to the laptop's motherboard in order to connect external peripheral devices to a computer cost about [redacted] ***See*** **Exhibit 4**. Any combination of these additional features would make the computer more attractive to some consumers.

38 [redacted]

2. The Computer Industry Is Extremely Competitive, with All Material Inputs Declining in Cost During the Class Period

79. The computer industry is widely acknowledged to be extremely competitive,[39] with razor thin profit margins, typically on the order of 3 to 5 percent or less of sales price,[40] i.e., $5 to

[39] "This analysis [of a monopolistically competitive market] is well illustrated by the personal computer industry. Originally, such computer manufacturers as Apple and Compaq made big profits. But the personal computer industry turned out to have low barriers to entry, and numerous small firms entered the market. Today, there are dozens of firms, each with a small share of the computer market but no economic profits to show for its efforts.

The monopolistic competition model provides an important insight into American capitalism: the rate of profit will in the long run be zero in this kind of imperfectly competitive industry, as firms enter with new differentiated products." P. Samuelson and W. Nordhaus, *Economics*, 19th Edition, 2010, pp. 239-240, available at https://books.google.com/books?id=gzqXdHXxxeAC&pg=PA239&lpg=PA239&dq=%22monopolistic+competition%22+%22personal+computer+industry%22&source=bl&ots=y7o6yJy8IV&sig=NW_JhAxOTRbf_8UHwUB_GKrp40E&hl=en&sa=X&ei=TrZSVamuDNTjoASj_IGwDg&ved=0CD4Q6AEwBQ#v=onepage&q=%22monopolistic%20competition%22%20%22personal%20computer%20industry%22&f=false .

"The market availability of all components on the open market combined with the extreme ease of assembly make the PC a quintessentially modular product. This means that in nearly every stage of the value chain there is intense competition. Bresnahan and Richards described these dynamics as "vertical competition," an environment in which firms at each stage of the value chain encourage competition at the other stages.' So, for example, Microsoft certifies microprocessors made by firms other than Intel as Microsoft-compatible; Intel develops microprocessors to work with the Linux operating system. Price competition is continuous and fierce: even acquiring a dominant position cannot entirely protect a firm (with the possible exception of Microsoft)." M. Kenney and J. Curry, "The Internet and the Personal Computer Value Chain," in BRIE-IGCC E-conomy Project, *Tracking a Transformation: e-Commerce and the Terms of Competition in Industries* (Washington, D.C.: Brookings Institution Press), chap. 7, 2001, p. 153.

"The PC industry has undergone a significant shift in structure since the mid-1990s, driven by industry-wide competitive pressures and by the ascendance of Dell Computer to the top of the industry. Facing shrinking margins and reacting to the inherent efficiencies of Dell's direct-sales/build-to-order strategy, PC companies have revamped their supply and distribution chains to reduce costs and respond more quickly to demand signals." J. Dedrick and K.L. Kraemer, "The Impacts of IT on Firm and Industry Structure: The Personal Computer Industry," *California Management Review*, Vol. 47, No. 3, Spring 2005, p. 139.

"American firms like Dell, Gateway, and Compaq responded positively to the emergence of Intel's new notebook PC platforms. Exploiting the increased modularity of the product, the firms quickly increased outsourcing to Taiwanese firms to reduce costs, while concentrating their efforts on product conception, marketing, and distribution. Taiwanese firms became adept at the recursive and relatively superficial work of product design. Rapid product life cycles and intense competition justified outsourcing the most detailed aspects of design and redesign to Taiwanese ODMs." M. Kawakami, "Inter-firm Dynamics in Notebook PC Value Chains and the Rise of Taiwanese Original Design Manufacturing Firms," in M. Kawakami and T. J. Sturgeon, Ed., *Inter-firm Dynamics in Notebook PC Value Chains and the Rise of Taiwanese Original Design Manufacturing Firms*, (London: Palgrave MacMillan), chap. 1, 2011, p. 26.

"Our main result is that a vintage-capital model that combines a competitive market structure with a rapid rate of innovation is well able to explain the observed paths of prices, as well as sales

$10 dollars ***total*** profit on a $199 computer. One recent analysis estimated the weighted average profit per PC sold by the five largest PC makers over the 2007-13 period to have ranged from about $10 to $25 (**Figure 12**). The documentary record shows computer OEMs going to great lengths to reduce even the smallest of costs in order to maintain that slim margin of profitability.[41]

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and consumer income, over a typical PC's product cycle. The analysis implies that rapid price declines are not caused by upstream innovation alone, but rather by the combination of upstream innovation and a competitive environment." A. Copeland and A. H. Shapiro, "Price Setting in an Innovative Market," Federal Reserve Bank of New York, Staff Report 462, Revised March 2013, p. 1.

Retailers in this litigation have also confirmed the highly competitive nature of sales for PCs:

- [redacted]

[40] Dells average net profit over the 2006 to 2010 period was about 4.5 percent of sales, including its higher margin non-PC lines of business. Y. Kuang, "Financial Analysis of Dell and HP," *available at* http://www2.uhv.edu/kuangy/acct6351/Sample%20Projects/sample%20project%20with%20pro%20forma%20%20analysis.pdf ; *see also* http://images.hoovers.com/images/i/samples/Dellreport.pdf.

[41] *See, e.g.,*

- [redacted]

Figure 12: Average Per-PC Profit for Five Largest PC Manufacturers

Source: http://www.theguardian.com/technology/2014/jan/09/pc-value-trap-windows-chrome-hp-dell-lenovo-asus-acer

80. Furthermore, prices in the computer industry were declining more or less continuously, at rates in the 20 to 30 percent per year range throughout the class period. Testimony in this litigation from industry participants confirms that prices for computers declined steadily over the class period.[42]

[redacted]

81. This anecdotal testimony is confirmed by an exemplary analysis of major component parts in personal computers. **Figure 13** depicts the decline in price for laptop PC inputs from 2004 to 2008:

Figure 13: Quality Adjusted Costs for Laptop Inputs Declined Substantially from 2004 to 2008

82. **Figure 14** demonstrates that input prices for desktops from 2004 to 2008 were similarly declining:

Figure 14: Quality Adjusted Costs for Desktop Inputs Declined Substantially from 2004 to 2008

83. Making use of data produced in this case, I estimate that on average, the cost of components used in manufacturing a laptop computer declined by roughly [redacted] percent a year over the class period.

84. **Table 4** shows that a laptop computer containing on average $[redacted] in materials in the first quarter of 2004 would have seen those materials costs drop by an average of $[redacted] per quarter through 2008, while a desktop containing $[redacted] in materials in the first quarter of 2004 would have seen those components drop by an average of $[redacted] per quarter through 2008.

Table 4: Quality Adjusted Input Costs Declined at Substantial Rates

85. The whole point of the intense competition found in the personal computer industry is that prices are driven down continuously. The continuous cost declines are driven by declining costs for improved versions of components going into computers, and savage competition with competitors vying with one another over market share. The net effect is that the fiercely competitive OEM computer makers are constantly slashing the prices effectively paid by buyers, by cutting prices on existing models, and improving features offered in new models introduced at the same price points at which less capable computers previously were sold. In one peer-reviewed and

published study, two coauthors and I showed a decade ago that quality-adjusted price declines in just the semiconductor components going into a PC were responsible for somewhere between 40 to 60 percent of the decline in personal computer price registered in 1999.[43]

86. Intense competition in the PC marketplace meant that both OEM computer makers and retailers were trying to pack as many desirable features as possible into a PC designed to be sold at a particular retail price point. Thus, given that a retailer had a strategy of introducing new products at particular price points, and that the retailer and PC OEM agreed on a particular price point target, the consequence in the *but-for* world of a decline in the price of a major component, like an ODD, would be that additional features could be added to the PC in order to make the product as attractive as possible in competition with other brands and retailers. Absent a small overcharge, small improvements would be possible; absent a large overcharge, major improvements in PC characteristics would be possible in the *but-for* world that would have prevailed absent the alleged ODD price-fixing.

3. The ODD Is Considered a "[redacted] for the Purposes of Costs and Cost Savings by Industry Participants

87. Note that ODDs were one of just a handful of computer components regarded by OEMs as "major" or "[redacted] components." For example, Toshiba (both a defendant and a manufacturer of laptops) has produced component-level data in this litigation. It refers to only [redacted] components as "[redacted]"—[redacted][44]

88. In many of Toshiba's notebook computer models, the ODD accounted for nearly the same share component costs [redacted]

[43] A. Aizcorbe, K. Flamm, and A. Kurshid, "The Role of Semiconductor Inputs in IT Hardware Price Decline: Computers versus Communications," in E. R. Berndt and C. R. Hulten, Ed., *Hard-to-Measure Goods and Services: Essays in Honor of Zvi Griliches*, (Chicago: National Bureau of Economic Research and University of Chicago Press), 2007, p. 369, available at http://www.nber.org/books/bern07-1 .

[44] *See* T-ODD-00000545_TSB PC TOV calculation_2006-2010.xlsx.

[redacted] **Figure 15** The following figure depicts the component parts of one Toshiba notebook in 2007, clearly showing the key nature of the ODD:[45]

Figure 15: The ODD Is a "[redacted]" Representing a Large Share of Computer Costs (Toshiba Model PSAD0U-0N500N)

89. **Exhibit 5** makes the same point for other models of computers produced by Toshiba in 2007 models – that is, the ODD accounts for a substantial portion of the cost of a computer.

90. Toshiba's characterization of the ODD as a "[redacted]" is confirmed [redacted]

[redacted]

[45] *Id.*

[46] *See* [redacted]

[redacted]

91. The ODD and other key components were the target of constant pressure to cut costs by computer OEMs, who put pressure on their suppliers to reduce prices by even small amounts, as they maneuvered to achieve cost targets needed to supply the new model configurations requested by retailers.[47]

[47] *See, e.g.*,

- [redacted]

92. That the ODD was considered such a critical cost component puts into the context the focus and success of this cartel. It would make much less economic sense for a group of firms to form a cartel, and risk the potential costs if discovered, in order to elevate price for one of the smaller and less important components of the computer (of which there are over [redacted] contained in Toshiba's computers, *see* **Exhibit 4**), rather than such a critical (and larger cost) component.

4. Pass-Through Can Be Measured, Using Methods Common to the Class, at Both the Initial Price Point and Through Later Declines in Price

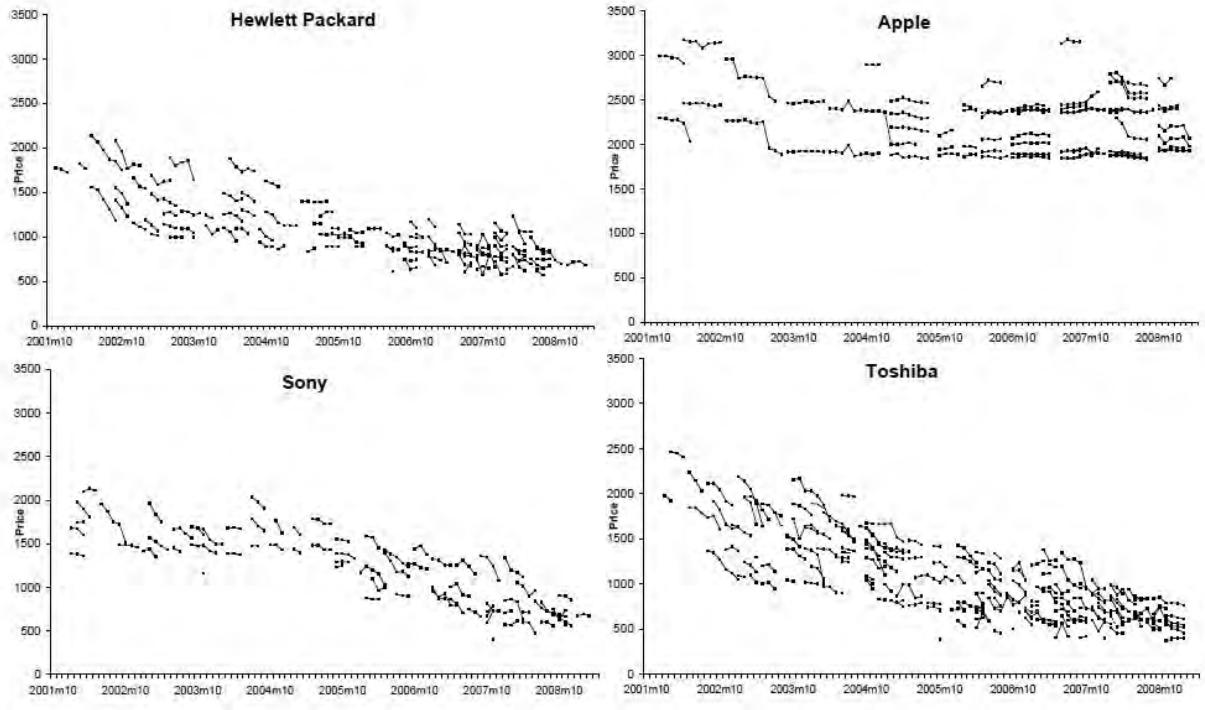
93. Conceptually, there were two ways in which continuing component cost declines affected computer prices. First, new features and improved quality components were being added to every new computer design, in an environment of constant dramatic price declines and impressive product improvements, where new computer models were shipped to replace older models approximately every 3 to 4 months.[48] Second, even within the relatively short time window (3 to 4 months) in which a newly introduced computer model continued to be sold in significant volume after its initial introduction, further cost declines were often significant, and prices continued to drop as costs declined for OEMs, and their retailers, driven by competition. Intense competition among computer makers, and across the stores retail channels through which their products were sold, drove prices down as costs came down.

[48] *See, e.g.,*

- [redacted]

94. **Figure 17** is from a study by economists at the Federal Reserve Bank of New York showing prices for different models of 15-inch laptop computers made by Hewlett Packard, Sony, Toshiba, and Apple, over their relatively brief product cycles:

Figure 17: Federal Reserve Bank of New York Analysis Showing Short Product Cycles for Laptops



95. The authors of this study (using average monthly prices for specific pre-configured computer models derived from checkout scanner data for 2001 through 2009 from a sample of retail outlets located across the U.S.) observe that "PC manufacturers generally sell over half their units by the second month on the market, and that by the third month they have sold between 70 and 90 percent of their units."[49] Even over these very short product cycles, prices for existing models come down significantly: "By mid-cycle, PC prices fall 6 percent, and by the end of the cycle, they fall by 12 percent."[50]

[49] Copeland and Shapiro, 2013, p. 10.

[50] Ibid., p. 9.

a. Common and Accepted Methods Exist to Measure the Overcharge Embedded in the Initial Purchase Price of a Computer, Taking Into Account the Quality of the Computer

96. The constant improvement in the characteristics and features put into new computers offered at any given price point, is readily apparent in data produced in this case. [redacted]

97. Note that the Apple products have somewhat longer product lives than PCs, and the price profile for Apple products over their life cycle is flatter, compared with the price contour for PCs, so that most of the price performance improvement for Apple products came through the introduction of new and higher quality products at existing price points, and relatively less through declines in price for existing models.

98. [redacted] What this demonstrates is that there is an innovation cycle in this industry where costs and prices are declining – both in quality adjusted and nominal terms. Thus, additional cost reductions— for example lower prices for ODDs without the conspiracy—would have been passed on in receiving better quality for the same price or a lower nominal price.

Figure 18: Changes in Quality Level of Apple MacBooks Sold at Best Buy

99. **Figure 19** demonstrates the same point of declining prices versus increasing quality for Apple Desktops:

Figure 19: Apple Desktop Prices and Quality Levels at Best Buy

100. **Exhibits 6A-B** make this point another way for personal computer producer HP, by showing how from quarter to quarter, improved components create more capable computers at every price point. [redacted].

101. Thus, the effect of collusion in raising a major component price, like an ODD, would have been felt by consumers in reduced quality for computers priced for sale at any given price point. The reduced quality of a newly introduced computer sold at a particular price point would be

51 [redacted]

expressed as an increase in the quality-adjusted price for computers sold, relative to a *but-for* world in which the ODD price had not been elevated.

(1) Using Hedonic Price Regressions on Data Provided by Acer, Toshiba, HP and Dell at the Component Level, Pass-Through to Class Members Exceeds 100 Percent

102. The standard method used by economists, and government statisticians, in measuring prices for differentiated high tech goods like computers, which have many rapidly changing dimensions of quality and are sold for only short periods of time, is to control for those product characteristic in a statistical model that measures the relationship between product characteristics and product price at any moment in time. This is known as a hedonic function.

103. Economists at the German Statistical Office summarized the widespread acceptance of this method by economists and the governments they sometimes work for as follows:

> When calculating price indexes, central importance is attached to how quality changes to observed goods can be taken into account. The objective of official price statistics is to measure what we call "pure" price changes, i.e. price movements purged of the adulterating influence of quality change. Hedonic methods, as they are now known, are special techniques for quality adjustment that have recently been incorporated into official German price statistics. They particularly lend themselves to technological goods which are subject to rapid progress and cannot be observed over a long period with the quality remaining unchanged. For hedonic quality adjustment, a good is conceptually broken down into quality features and then the influence of these features on the price is determined using regression analysis. In this way, those price changes that result only from qualitative changes to certain features can be mathematically separated from pure price changes and eliminated.
>
> The United States has played a pioneering role in introducing hedonic methods into national price statistics, implementing a hedonic price index for computers in the mid-1980s. Hedonic methods have since been applied to many more products in the USA, such as housing rent since 1987, clothing since 1991, multi-family homes since 1993, digital phone systems since 1997 and television sets since 1999.[52]

104. This method is widely accepted and used by economists and statisticians, and is even used by government statistical and economic agencies around the world to measure quality-adjusted price for high tech products as they construct their national income accounts. The U.S.

[52] *See* S. Linz and G. Eckert, "Introducing hedonic methods in price statistics," available at https://www.destatis.de/EN/FactsFigures/NationalEconomyEnvironment/Prices/HedonicPC.pdf?__blob=publicationFile .

government's estimates of GDP, for example, use computer price indexes making use of hedonic quality adjustments from a hedonic regression model in measuring US national income, as do national income accounts for other OECD countries. Two of the economists responsible for the U.S. national income accounts note that hedonic regression methods seem to work well, and track the changes in quality-adjusted prices that can be measured using other methods when prices for high tech goods with fixed characteristics are collected frequently:

> There is evidence that a 'well constructed' matched model index for rapidly changing high-tech goods could yield a price index that adequately controls for quality differences and that this price index is consistent with a quality-adjusted price index constructed using hedonic methods. Aizcorbe, Corrado, and Doms (2003) constructed price indexes for microprocessors using high frequency disaggregated data on models whose characteristics were constant over time and found that their matched model price indexes were remarkably close to those constructed using hedonic methods (table 2). Similar results were reported in Aizcorbe, Corrado, and Doms (2000) for personal computers. Silver and Heravi (2001, 2002) report similar findings using scanner data for washing machines and televisions. However, given that we often do not have the abundant data necessary to construct such a matched model price index, then the hedonic price index is the practical approach for measuring prices of rapidly changing goods or goods that by nature are heterogeneous (e.g. custom software or homes).[53]

105. Hedonic regression methods are also used by the Bureau of Labor Statistics to estimate US consumer and producer price indexes. A vast academic research literature, including a number of studies I have authored, use hedonic methods to measure quality-adjusted price for computers and other high tech products. The use of a quality-adjusted price to analyze changes in pricing for computers is standard in the economics literature and government statistics.

106. Controlling for computer characteristics using this hedonic approach, it is possible to show statistically that there is a stable and predictable relationship between computer cost, and the introductory prices at which a computer is first sold by retailers. This is not surprising, since economic theory unambiguously predicts this relationship between observed price and the so-called hedonic function. As economist and industrial organization expert Ariel Pakes has written, "The

[53] D. Wasshausen and B. R. Moulton, "The Role of Hedonic Methods in Measuring Real GDP in the United States," *available at* http://www.bea.gov/papers/pdf/hedonicGDP.pdf.

hedonic function is the expectation of marginal costs plus that of the mark-up conditional on "own-product" characteristics."[54]

107. Using data produced in this litigation on computer costs and product characteristics, I have performed multiple additional studies that show how changes in computer component costs are reflected in the quality-adjusted computer prices at their introduction into the market. These new hedonic studies confirm that a cost reduction (or increase) is "baked in" with roughly 100 percent pass-through rates into the initial prices that new computer models are sold at when they first hit the market.[55]

(2) Additional Analysis of Pass-Through on OEMs

108. As I indicated in my above discussion of OEMs passing through computer costs to their customers, I have also conducted additional analyses of OEM pass-through for Acer, Dell, HP (both for its sales to retailers and its direct sales to consumers), and Toshiba. I also have updated my estimates of pass-through rates for Dell direct sales.

109. Before summarizing the results of my analysis, it may be useful to revisit the approaches I used in my previous reports to estimate pass-through rates. Most of the pass-through estimates I have presented are estimated using the fixed effects method I summarized in my Report.[56] The fixed effects method is useful because it provides consistent estimates of pass-through even when product characteristics cannot be directly observed. However, fixed effects methods also require that repeated observations on price and cost be available over time. That requirement was not met for the customized systems in Dell's direct-to-consumer data. Consequently, I use the hedonic method discussed above, which includes detailed computer characteristics in the regression model.[57]

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[54] A. Pakes, "A Reconsideration of Hedonic Price Indexes With An Application To PC's," *American Economic Review*, 2003, vol. 93, no. 5, pp.1578-1614.

[55] It is worth noting that computer OEMs and retailers commonly alternate periods of promotional discounts with sales at an initial list price when they first bring a new computer model to market. These are typically averaged together in planning product launches, when comparing initial revenue targets to cost targets.

[56] Flamm I, ¶ 230.

[57] Flamm I, ¶¶ 245-246.

110. For my analysis of OEM pass-through, I adopt the method I used for Dell direct-to-consumer sales. The use of this approach follows from the acquisition practices employed by large retailers and computer OEMs, which I describe in detail above. New computers reaching retailer shelves are destined to have short life-cycles, as retailers reset computer lineups by selecting computers with new configurations three to four times a year. An implication of this ongoing process is that the procurement prices agreed upon between OEMs and retailers are relatively constant over the product's life cycle, as is evident in the number of computers in the retailer data with no cost variation.[58] The absence of significant procurement cost variation in the retailer data implies that the prices observed in the OEM data for products sold to retailers will also typically be constant. Therefore, I analyze OEM pass-through to retailers using the prices set between retailers and OEMs as they negotiate the computer configurations to be offered to retail customers in each procurement cycle.

111. In my estimates of OEM pass-through to retailers presented below, I capture the negotiated price by using two relevant measures of initial price. The first of these measures is the price from the largest transaction on the first day a model is sold by OEMs to retailers.[59] The second measure I use is the quantity weighted average price for the month when the model is first sold. The costs used in my models to measure the initial price pass-through rate corresponds to each price, that is, I use the cost associated with the largest first-day transaction and the quantity weighted average cost for the month, respectively.[60] Using these two prices provides a robustness check, to assure that the estimate is not a result of idiosyncratic transactions.

112. In each of my OEM to retailer analyses presented below, I estimate several variants of the model. In one set of alternative model specifications, I use two sets of explanatory variables that differ in how certain variables are entered into the model. For example, in specification [1] (see **Exhibit 7A-B**, for example) I include the size of the hard drive as a single, continuous variable whose coefficient represents the change in the price of the computer when the size of the drive

[58] See Flamm I, Pass-Through Exhibit 2 - Pass-Through 11.

[59] I note an exception below in my discussion for HP.

[60] I note exceptions below for HP and Toshiba.

increases by one gigabyte. Specification [2] controls for hard drive by including a dummy variable for each value of hard drive observed. The coefficients in that model show the price effect of a particular size of hard drive relative to other sizes. Continuous variables represent a more restrictive modeling approach. However, when the number of distinct computer models available for analysis is relatively small, as is the case in this analysis of OEM pass through rates, using continuous variables permits me to control for the price impact of important computer characteristics, such as the size of the hard drive, with greater precision. The second modeling variation I consider is the exclusion and inclusion of GDP, which will control for macroeconomic conditions. Again, given data limitations, it may not be useful to include additional variables, such as GDP, that are unlikely to provide much additional explanatory power to the model, but significantly reduce the precision of estimated coefficients.

(a) Acer

113. Acer, a computer OEM,[61] provided sales data for desktop and laptop computers, including for its Gateway and eMachine brands. I have evaluated the pass-through rates for Acer products using each of two the methods I introduced in my earlier report. For Acer's sales to retailers, I estimate the "baked in" initial pass-through rate by controlling for detailed computer characteristics. For Acer's sales to distributors and other resellers, where there is substantial price and cost variation after first sale, I estimate pass-through using the fixed-effects method.

114. Since Acer did not provide information about the features of the computers it sold to retailers, I identify Acer computer model characteristics using descriptions found in other third party data sets. For example, [redacted]. This approach permits me to control on a model-

[61] http://www.acer-group.com/public/index/services.htm. *See* **Exhibit 7A-B** for the data sources discussed in this section.

[62] The model description includes CPU model numbers, which were used to find detailed CPU characteristics from ark.intel.com and www.cpu-world.com.

by-model basis for detailed computer characteristics, including detailed CPU characteristics. The CPU characteristics I control for include the CPU manufacturer as well as CPU performance indicators including gigahertz ratings, cache, number of cores, number of threads, and bits. In addition to CPU, I am able to control for each computer's hard drive size, RAM memory, ODD type, screen size (for laptops), and operating system. Using this approach, I am able to identify detailed characteristics for 75 desktop and 53 laptop models for which I also have price and cost information.

115. Acer sales to retailers are presented in **Exhibit 7A.** The pass-through rates for Acer sales to retailers are all greater than [redacted] percent. Desktop coefficients average [redacted] percent, and all of the coefficients are statistically significantly greater than zero but not significantly greater than [redacted] percent. For laptops, the pass-through estimates average [redacted] percent and all are significantly greater than [redacted] percent.

116. Acer's estimated pass-through rate for sales to other resellers is presented in **Exhibit 7B**. Lagged cost estimates are selected for both desktops and laptops. The estimate for desktop computers is [redacted] percent. The estimates for laptop computers is [redacted] percent. Both estimates are statistically significantly greater than zero, and neither is significantly different from [redacted] percent.

(b) Dell

117. My analysis of Dell pass-through has been extended in two ways.[63] First, Dell provided additional data on its direct to consumer sales. These data have been used to update my previous Dell pass-through analysis. Dell has also provided data on its sales to retailers, which I have used to conduct a new analysis of Dell's pass-through rate in this sales channel.

118. It is my understanding that in January 2014, Dell produced additional transactional data (including detailed data on its costs) ***representing over 3 million observations for more than 7 million personal computers sold in the United States***. These data allowed me to update my pass-through estimates for four of the six Dell computer "brands" I previously analyzed, using

[63] *See* **Exhibits 7C-D** for the data sources discussed in this section.

substantially more observations. The brands I have updated are the Inspiron 6000, the Latitude D600, the Latitude E5500, and the Optiplex 745.

119. Dell's estimated pass-through rates for computers are presented in **Exhibit 7C**. My updated pass-through rate for Optiplex 745 desktop computers is [redacted] percent. The resulting updated revenue-weighted average for Dell desktop computers is [redacted] percent, compared with my previous estimate of [redacted] percent using a more limited dataset. My updated laptop pass-through rates are [redacted] percent for the Inspiron 6000, [redacted] percent for the Latitude D600, and [redacted] percent for the Latitude E5500. The resulting revenue-weighted average of the pass-through rate for laptops is [redacted] percent, compared with [redacted] percent previously. All of the updated pass-through estimates are significantly greater than [redacted] percent, with the exception of the Latitude E5500 which is not statistically different from [redacted] percent.

120. Dell also provided data for its sales to the retailers [redacted] Using this data, I have estimated Dell's pass-through rates for its sales to the retail channel. For this estimate, I use a hedonic regression. Dell provided descriptions of the inputs used in its pre-configured computers, allowing me to identify the following computer attributes: detailed CPU characteristics (manufacturer, GHz, cache, cores, threads, and bits), hard drive size, RAM memory, ODD, screen size (for laptops), network card (laptops), graphics card manufacturer, battery cells (laptops), Microsoft office, other premium software (such as Adobe), and the operating system. Detailed characteristics have been identified for 68 desktop models and 130 laptop models.

121. Dell sales to retailers are presented in **Exhibit 7D.** The pass-through rates for Dell's sales to retailers are all greater than [redacted] percent. Desktop coefficients average [redacted] percent, and all of the coefficients are statistically significantly greater than [redacted] percent. For laptops, the pass-through estimates average [redacted] percent and all are significantly greater than zero. Only one out of the eight estimates is significantly greater than [redacted] percent.

(c) HP

122. HP, a computer OEM, has produced bill-of-material (BOM) data that provides model-level information describing the inputs included in the computers it sold to Best Buy.[64] HP provided similar data for a randomly selected sample of models it sold directly to consumers through its website.[65] HP also provided records of its sales to resellers as well as records for its direct-to-consumer sales. HP's sales data sources include revenue and quantity information but not cost. HP has recently provided standard costs for some of the models included in its sales files. The information from these various sources has been assembled for use in estimating pass-through rates for HP's sales to retailers and for its direct-to-consumer sales.

123. HP sales to retailers are presented in **Exhibit 7E**. Since the reseller sales data provided by HP do not include the date (year and month are provided), I cannot identify the price of the earliest transaction as I did for other OEMs. Consequently, only the average price from the earliest observed period is used for HP. This price is matched to the earliest observed standard cost from the cost files.[66] Control variables included in HP's retailer pass-through model include detailed CPU characteristics, hard drive size, RAM size, ODD type, the type of the second ODD if included in the model (desktops), screen size and resolution (laptops), battery wattage (laptops), and operating system. The desktop analysis includes 118 computer models, while the laptops analysis uses 84 models.

[64] http://www8.hp.com/us/en/home.html. *See* **Exhibit 7E-F** for the data sources discussed in this section.

[65] The detailed data was requested for both configure-to-order (identified as CTO sales in HP's direct sales data) and preconfigured models (identified as STO sales in HP's direct sales data) sold to consumers on HP's website. HP provided descriptions only for STO models.

[66] The dates associated with HP's standard costs frequently do not match the period when sales are observed. However, standard cost systems set costs according to expected costs. AccountingTools.com defines standard cost as "a predetermined cost that is based on original engineering designs and production methodologies…." http://www.accountingtools.com/definition-standard-cost. For a description of standard costs and standard cost systems, *see* http://ocw.mit.edu/courses/sloan-school-of-management/15-521-management-accounting-and-control-spring-2003/lecture-notes/web_class12.pdf: "Standard costs are the expected costs of manufacturing the product."

124. The average pass-through rate estimated for desktops is [redacted] percent. For laptops the average pass through rate is [redacted] percent. All of the estimates are statistically significantly greater than zero, and none of them is significantly different than [redacted] percent.

125. The same approach is used to estimate the pass-through rate for HP's direct-to-consumer sales, found in **Exhibit 7F**, though the prices associated with the first transactions are identified. Prices are matched to the earliest observed standard cost. For direct-to-consumer sales, 72 computer models were used in the desktop analysis and 62 laptop models were used. For direct sales, the average pass-through rate for desktops is [redacted] percent. All of the desktop pass-through rates for HP's direct-to-consumer sales are statistically significantly greater than [redacted] percent. Five of the eight laptop models had pass-through rates that are statistically significantly greater than zero.[67] For laptops, the average of the statistically significant estimates is [redacted] percent. Laptop estimates are not statistically different than [redacted] percent.

(d) Toshiba

126. Toshiba, a computer OEM, provided computer sales information and, separately, BOM-level cost information for models it sold to US retailers.[68] Cost information was provided for roughly 200 laptop computer models. To estimate the pass-through rate, Toshiba's earliest observed cost is matched to prices.[69]

127. Toshiba's BOM data included descriptions of the inputs used in its computers. That information was used to identify each model's detailed CPU characteristics (manufacturer, bits, cores, threads, GHz, cache), hard drive size and speed, RAM size, ODD type and characteristics, screen size and resolution, network card, graphics card manufacturer, battery cells, Bluetooth capability, and operating system. The results are presented in **Exhibit 7G**. The average pass-through

[67] The base model results are all statistically significant. When including GDP, the pass-through estimates decline modestly, but the standard errors also increase significantly, suggesting that the model results are being affected by the limitations of the sample size.

[68] http://www.toshiba.com/us/about. *See* **Exhibit 7G** for the data sources discussed in this section. The cost is provided in yen, so it is converted to US dollars.

[69] Cost is the earliest observed model-specific "TOV" cost from Toshiba's BOM data. The TOV is reported by quarter, and there is typically only a single cost observation provided per model. The cost variable is the same in the "first price" model and the "average price" model.

rate estimated for Toshiba's sale of laptops to retailers is [redacted] percent. All of the estimates are statistically significantly greater than zero, and none of them are significantly different from 100 percent.

128. This additional analysis of the overcharge embedded in the initial price points of preconfigured computers confirms the findings of a similar analysis I did for configure-to-order Dell computers in my previous report.[70]

(e) Summary on OEM Pass-Through

129. This analysis, covering 859 separate observations for HP, Dell, Acer and Toshiba computers, demonstrates that for given computer characteristics, a cost decrease is passed through at roughly 100 percent into price for the new computer model. This means that if a computer manufacturer—and retailer selling the new model computer—are aiming for a particular price point, and therefore, target cost, it is the characteristics of the computer that get adjusted to meet the price and cost targets. This is what the statistical model is telling us.

130. If costs were to drop in the *but-for* world, product improvements that bring cost back up to the target for some price point would be undertaken (for those retailers setting pre-determined configurations for computers at specific target prices), such that a superior computer would have been offered at that same price point. The difference between that target price point and the lower *but-for* price at which the market would have valued the now (in the *but-for* world) inferior actual computer represents harm to the consumer.

131. The hedonic regression functions we have describe how computer characteristics, and the cost of producing those characteristics, get translated into an observed market price. By assumption, in the but-for world, the characteristics of the computer do not change, but the cost of producing that computer declines, as the alleged collusion is removed. The estimated hedonic functions, showing an approximately one-to-one pass-through of cost declines into initial market price, tell us that that same computer would have had a market value below the initial price point at which it was sold in the actual world. Thus, with one-for-one pass-through of cost declines into

[70] *See* Flamm II, ¶¶ 217-220, Pass-Through Exhibit 13.

lower prices, the decline in component costs associated with no collusion, and no overcharge, is an estimate of what the reduced market price of a consumer's computer would have been absent the component cost-raising collusion.

132. So for, example, if collusion had raised the price of the components going into a $999 computer by $4 in the actual world, the price of that same computer in a collusion-free *but-for* world would have been $995. In the *but-for* world, a superior computer with better characteristics in some dimension would have been offered at the $999 price point.

133. Given some set of characteristics for a computer in the real world, the hedonic function allows us to estimate what a computer with those same characteristics would have sold for in the but-for world, had the cost of those identical characteristics been lower. Even if computers were only sold only at fixed price points (an assumption that is inconsistent with much of the evidence reviewed above), so that improved computers would have been instead sold at those fixed price points in the *but-for* world, the hedonic pass-through results allow us to predict how much lower the actual observed computer configurations would have been priced, had they still been sold, in a *but-for* world of marginally lower computer component costs. The hedonic price functions we have estimated empirically tell us that generally, the price of actual world computer configurations, if they were to instead be sold in a *but-for* world of lower computer component costs, would have declined in price by about the value of the decline in component costs.

(3) Data Demonstrates that Costs Included in the Initial Price Point Were Passed-On To Consumers

134. I have also analyzed the relationship between procurement cost, computer characteristics, and price, for different retailers' initial sales prices for various laptop and desktop computer models they sold. Estimates from those models are presented in the following table, **Table 5,** with detailed results presented in **Exhibits 8A-F**. These results show that the "baked-in" pass-through of their procurement cost is always positive and statistically significant, and generally at or above 100 percent.

Table 5: Retailers Passed Through Introductory Costs

135. My analysis of retailers passing through their procurement costs is based on all of the transactions for a model that occur within 30 days of the model's first observed sale. In those transactions, I identify observations associated with a variety of prices. Specifically, I identify any sale with a price ending in the number "9." Next, I identify all of the transactions ending in "9" that are also equal to the introductory price, which I define as the most frequently observed price on the first day the product is sold. Finally, I identify all of the transactions with prices ending in "9" that are also associated with the most frequently observed price during the period. That is, I analyze pass through using prices associated with 4 groups of transactions: all transactions, all sales occurring at price points, all sales at introductory price points, and all sales at the most frequently observed price (if it is also a price point).

136. For each retailer, I use a hedonic pass-through model in which I identify detailed characteristics using product description fields provided with the retailer data. For each retailer, I am able to control for detailed CPU characteristics, hard drive size, RAM size, ODD, screen size, and other characteristics. In the case of Best Buy, I was able to conduct a complementary analysis using HP and Toshiba data, which provides an alternative (though largely overlapping) set of control variables. All of the models include a time trend. I also estimate the model with alternative sets of control variables, by including certain variables as either single, continuous measures, or as a set of dummy variables. I also examine alternative control variables for macroeconomic factors, by either including GDP and a dummy variable for the introduction of the Vista operating system, or, if

there is a large number of models available to use in the analysis, by including dummy variables for the year/month the product was introduced. I analyze the data at the transaction level (with potentially millions of observations), at the weekly level (with roughly 4 observations per model), and at the model level with a single observation per model. Across all of these alternative model specifications, the pass-through rates are all large and typically near or greater than 100 percent,[71] demonstrating that, even at initial for price points, after controlling for the characteristics of components going into a pre-configured computer model, there is a roughly one-for-one link between variation in retailer procurement costs and initial sales prices.

137. [redacted]. These pass-through rates link OEM input costs, such as the cost of the ODD, directly to the initial prices paid by retail consumers.

138. What is going on in these results using retailer data, then, is that at any price point, computer characteristics are altered so that the predictable 100 percent pass-through relationship tying computer cost to computer price is being maintained. This is just statistical methods confirming the picture painted by the documents discussed earlier: intense pressure to reduce the cost of major system components is applied to suppliers by OEMs, and if that is insufficient, characteristics of computer models are changed so that the target cost for a particular price point can be hit by both OEMs and retailers. The net result is that a successful elevation in the price of a key system component, like an ODD, relative to its price in a collusion-free *but-for* world, is a reduction in the quality of the computer sold at that price point in the actual world, relative to the improved

[71] HP laptops sold at Best Buy have the lowest average estimates, with an average of [redacted] percent.

computer that would have been sold in the *but-for* world. The standard metric for gauging the effect in the marketplace of that reduced quality is an increase in quality-adjusted price, measured using the hedonic methods employed by both the government and researchers track quality-adjusted computer prices.

139. Thus, as computer components constantly get improved, and costs come down, the benefits are passed on to consumers in the form of higher quality, more powerful, more capable computers sold at any given price. Profitability by both computer manufacturers and retailers is assured by adjusting the characteristics of the computers sold so that the difference between the cost of the new model and its price, to the retailer, and then to the final buyer, provide each participant in the sale of that computer the minimum profit margin needed to survive in this intensely competitive marketplace.

140. It is important to note that once that quality reduction, and elevation in quality-adjusted price, is baked into the design of a computer model at product launch, that harm to consumers lasts the life of the product even if there were to be no further change in the costs for components going into that product. A removal of the overcharge in the *but-for* world, and a consequent decline in cost for the price-fixed component, would trigger an improvement in the quality of the designed-in computer configuration that would be measured as a decline in quality-adjusted price for the PC purchased at that price point. Therefore, the initial collusive overcharge would have continued to harm consumers after new PC product launches even if continuing costs (and prices) had been perfectly flat after the initial product launch.

141. But the continuing cost declines (or even increases) did not just affect the initial price and product characteristics selected by OEMs and retailers for the computers they sold. Continuing reductions in component prices, working through market forces generated by intense competition among PC OEMs and retailers, led to continuing reductions in the costs, and prices, of PCs after their initial launch in many cases. These continuing cost declines, when they occurred, also led to further price reductions. Note that for existing preconfigured computer models, using designs that have already been fixed prior to product launch, the impact of further cost declines is felt only in price reductions, and not in improved product characteristics.

142. This is in contrast to configure-to-order (CTO) computer models, sold to buyers through online channels like Dell, where improved product characteristics could be configured by buyers as they became available as configuration options. This is why my previous study of Dell CTO computer pricing controlled for product characteristics when estimating the impact of changes in computer cost on retail computer price using hedonic methods.

143. Similarly, I had previously analyzed the pass-through of reductions of computer cost for pre-configured PCs *after* launch, by retailers like Best Buy. (In these models, I controlled for product characteristics by using a fixed effect statistical model.) In all cases, I found pass-through of continuing cost declines to be close to or exceeding 100 percent.

(4) Defendants' Suggestion that Small, Systemic Cost Changes Were Not Passed-on to Consumers is Economically Absurd and Contradicted by Economic Evidence

144. Note that it is economically absurd to suggest, as Defendants do, that while retailers may pass-through 100%+ of small cost changes after product is first sold in marketplace, as statistical analysis established, they somehow ignore cost changes in setting initial prices for ODD products. Why pass-through changes in cost in one case, but ignore them in the other? There is no economic logic supporting this.

145. Defendants are simply silent as to why small cost changes after initial sale might be passed through into price with competitive pressures, but there would be no impacts or effects from equally sized changes in overcharge on initial quality-adjusted sales price. This is a logical conundrum that goes unremarked upon. This report now contains additional statistical analyses of "baked-in" pass-through at initial sales price that shows that initial pricing reflects essentially the same 100%+ pass-through rate for cost, with very similar empirically estimated pass-through coefficients. (*See* **Exhibits 7-9**, discussed above.)

146. With textbook perfect competition, economic theory says the pass-through from cost to product price is always 100 percent. With monopolistic competition, the form of imperfect competition one sees in industries with differentiated products, but still the domain of intense competition among firms, economic theory says the pass-through rates can vary above or below 100 percent. With economies of scale in developing innovative new products, such as are seen in the

computer industry, one would actually predict that pass-through would exceed one hundred percent.[72] Therefore, it is not surprising that empirical estimates of pass-through in the computer industry, such as have been documented in my previous reports, and are extended in this report, tend to cluster at or even above 100 percent.

147. One theoretical prediction of economic theory is that pass-through should generally be positive. There is no theory in economics supporting negative pass-through rates, and even only the most unlikely and extreme theoretical assumptions (discussed in detail in my previous report) would be consistent with a pass-through rate as low as zero.[73] Search as she might, Dr. Burtis was simply unable to find any empirical examples in the huge pass-through literature which supported a negative or zero pass-through with a statistically significant result.

148. The net result of configuration improvements with a *but-for* ODD price decline "baked in" to an initial price point would be a quality improvement in the computer sold at the particular price point. In effect, the quality-adjusted price of the computer sold at that price point would have declined. (The nominal—money price—might remain the same, but the quality of computer would increase, and thus the quality-adjusted price—price per quality—would decline.) The reason that OEM computer makers pass-through price declines into configuration improvements is simple—intense competition with other PC makers. If they do not improve their computers sold at a given price point as component prices decline, other computer makers will, and steal sales and market share from them. Competitive pressures force computer makers to sell the most feature-packed computers they can build at a cost budget consistent with the price the PCs are sold at, and just cover the razor-thin profit margin requirements they must meet to stay in business in this ruthlessly competitive business.

149. There are numerous documented examples of computer OEMs removing features to hit the cost target for a price point, or adding in features to make their product more competitive at a price point in response to a serendipitous component decline.[74]

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[72] Flamm I, ¶¶ 112-123.

[73] *See* Flamm II, ¶¶ 156-166.

[74] *See, e.g.,*

150. In its decision, the Court actually constructed an example that it believed to be a "plausible" scenario of why a cost change might not be passed through in some cases, **the $5 on $999 computer case. But the above discussion and review of the evidence shows that even $5 would was considered fair game for adding additional value for buyers by a computer manufacturer aiming at a competitive advantage over other producers selling at that same price point, and that there would be numerous improvements available to enhance the value of a PC to consumers available for even a small cost decline budge**t.

151. In other words, for even the $999 computer, a $5 decline in cost would give the computer manufacturer the opportunity to upgrade the processor, or add a useful interface for an external ExpressCard, or add another useful piece of software to the computer configuration, to make that computer more attractive to consumers than what other computer manufacturers were selling at that price point, in order to gain competitive advantage. If the other computer manufacturers faced the same decline in cost, then the same logic would drive them to add the additional feature, and the improvement in what a computer buyer could get for $999 would ripple across the configurations available at that price point throughout the industry. The computer producer who did not improve his configuration would be left at a relative disadvantage. A retailer who attempted to sell that OEM's less capable computer at the same price point would face the same disadvantage, relative to what other retailers were selling from other OEMs at that price point.

152. In any event, this is an empirical matter, amenable to empirical analysis and statistical test. The only evidence offered by Defendants on this subject is Dr. Burtis' $5 vs more than $5 cost pass-through test. But Dr. Burtis' estimate that a $5 cost increase would induce an entirely counterintuitive (and counter economic theory, for that matter) ***decline(!)*** in computer price has huge margin of error (not reported by Dr. Burtis, actually), as befits an estimate based on data for very noisy and small changes in cost. *See* **Exhibit 10**.

153. Dr. Burtis does not present a statistical test of whether the rate at which her less than $5 cost change is passed through is any different from >$5 cost difference, and this in fact appears not to be an accidental oversight. A formal statistical test says they are typically the same.[75] More importantly, using an estimation strategy with better statistical properties in the presence of measurement errors in cost (*see* below, and **Exhibit 10**), we reject the hypothesis that any of these pass-through rates, for cost changes above or below the magic $5 threshold, are zero!

154. Since the cost data used in this analysis clearly have significant measurement errors, the first difference estimator Dr. Burtis chooses to use (rather than fixed effects estimator I used in the original model she is modifying) is known to perform much more poorly in presence of measurement error, and has more bias in presence of endogeneity (which would be induced by measurement error) than the fixed effect estimator I used to analyze these data.[76] If I use my superior fixed effects estimator on the same <$5 cost changes data used by Dr. Burtis, I conclude there is statistically significant positive pass-through both above and below $5 cost changes, and no statistical difference between the effects of greater and less than $5 cost changes. *See* **Exhibit 10**.

155. In fact it is straightforward to see how small measurement errors in cost, as are implied by Best Buy's testimony about its pricing policies, produce biased estimates of pass-

[75] In 7 out of 10 cases, we cannot reject the hypothesis that above and [redacted]5 cost changes have the sam[redacted]hly $1 for $1 impact on price. (The exceptions are for [redacted] desktops and laptops and [redacted] laptops.) See Exhibit 17.

[76] "[E]rrors of measurement will usually bias the first difference estimators downward (toward zero) by more than they will bias the within [fixed effects] estimator." Z. Griliches & J. A. Hausman, "Errors in Variables in Panel Data," *Journal of Econometrics*, vol. 31, 1986, p. 95. "The previous analysis shows that under contemporaneous exogeneity and weak dependence of the regressors and idiosyncratic errors, the FE [fixed effects] estimator has an advantage over the FD [first difference] estimator when T is large. See J. M. Wooldridge, *Econometric Analysis of Cross Section and Panel Data*, (Cambridge: MIT Press) 2010, chap. 10, pp. 323-24.

through using the techniques Dr. Burtis has adopted in responding to my analysis. The basic reasoning behind this quite straightforward.

156. [redacted]

157. [redacted]

[redacted][77]

[redacted]

158. This means that if the new cost leads or lags the new price by days (or possibly even weeks), estimating pass-through using daily transactional data will seriously bias any estimate of pass-through. This is in addition to any measurement errors in cost due to price protection credits, rebates, market development funds, and other margin enhancements not being recorded on product-level accounting ledgers. The superiority of averages in dealing with potential measurement error was illustrated by the simulation (using actual Best Buy cost data) in my previous reply report.[81]

159. I can further extend this analysis by asking if there are any "magic" thresholds higher than a $5 change in cost, where a lesser cost change has no statistically significant impact. **Exhibits 11A-K** performed this analysis comparing pass-through above and below $5, $10, $15, etc. through $55. In all cases I found statistically significant positive pass-through above and below the "magic" threshold, and in most cases (62 out of 100), I found no statistically significant evidence of heterogeneity in pass-through above and below the "magic" cost threshold.

160. I say "magic" because there is no economic theory supporting the view that above—or below—some magic cost threshold, all further reductions in cost will simply be pocketed by a

[81] Flamm II, ¶ 17. For examples of economic studies making use of averages to mitigate the biasing effects of measurement error, see G. Solon, "Intergenerational Income Mobility in the United States." *American Economic Review*, vol. 82, no. 3, 1992, 393–408; D. J. Zimmerman, "Regression Toward Mediocrity in Economic Stature." *American Economic Review*, vol. 82, no.3, 1992, 409-429; B. Mazumdar, "Fortunate Sons: New Estimates of Intergenerational Mobility in the United States Using Social Security Earnings Data," *Review of Economics and Statistics*, vol. 87, no. 2, 2005, 235–255.

producer as additional profit. Economic theory says that even a monopolist, with no competition at all, when faced with a small cost reduction, should drop price at least slightly and pass-through some portion of the cost reduction into a lower price, expanding its sales volume, and profit, purely as the result of its economic self-interest in maximizing profit! Not lowering price to expand sales in response to a decline in cost, generally, would be leaving money on the table. In the ruthlessly competitive PC industry, no one ignores money on the table.

161. Finally, in order to further analyze the possibility of unspecified heterogeneity in ongoing pass-through of further, continuing cost reductions into price, I have employed econometric tools that allow one to study the issue of heterogeneity in pass-through at different price points. The tool I am using is known as quantile regression. Quantile is a technical synonym for percentile, and the basic idea of quantile regression is to allow for heterogeneity in effect of a variable (like cost) on an outcome (like price) for models sold at different points in the distribution of computer price.

162. I have therefore performed a fixed effects quantile regression relating price for computers sold at various percentiles[82] in the price distribution to costs, using [redacted] computer transactional sales data. The "fixed effect" is an unobserved model-specific quality parameter which affects price. The estimated pass-through rate is allowed to vary with quality, across computer models at different percentiles of the price distribution, so that, for example, the $999 computer has a pass-through rate that is different from that on a $299 computer. I also include time indicator variables that allow model prices, across the entire distribution of prices in any month, to shift up and down with changes in factors that shift supply and demand for computers, and generally affect computer prices.[83]

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[82] The x^{th} percentile of a rank ordering of computer models by monthly average price is the model whose price is such that all prices less than that price account for x percent of observed monthly average prices, while all prices above that price account for 100-x percent of prices. The median value of observations on a variable is the 50^{th} percentile of the distribution of that variable.

[83] The basic quantile regression model estimated was

$P_{mt} = b(i)\ COST_{mt}$, with

P_{mt} price of computer model *m* at time *t*

$COST_{mt}$ cost of computer model *m* at time *t*

163. As I commented in my previous report,[84] and demonstrated above, monthly averages have some distinct advantages over individual transactional data when analyzing determinants of price for different individual models of computers. This is because we would expect to observe substantial measurement errors in both cost and price when looking at daily transactional data.

164. Averaging prices over time mitigates this problem. By averaging over the course of a month, the variation in the data due to measurement error is reduced relative to the measured values of price and cost, reducing the downward bias caused by measurement error. When cost changes, even if the change is not captured on the correct day, it may well be captured over the course of the week, and will certainly coincide with a related change in price when averaged over the course of a month. Time averaging has been used in the economics literature in other contexts to reduce the bias caused by measurement errors. Indeed, in my previous report, I created a simulation which showed clearly how time averaging can mitigate biases created by measurement error.[85]

165. For these reasons, I used the distribution of monthly average prices, by computer model, in my quantile regression analysis. As a robustness check, I ran the same regressions using the distribution of weekly average price, by computer model, and found somewhat lower point

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b(*i*) pass-through coefficient for model *m* found at percentile *i* of the distribution of average monthly computer model prices.

The pass-through rate at percentile *i* in the price distribution, coefficient b(*i*), is assumed to vary with an unobserved index of relative computer quality, which in turn is some function of a model-specific fixed effect and some observation-specific disturbance term. A more detailed discussion of the fixed effect quantile regression model used here may be found in D. Wallace, "Did the Economic Stimulus Payments of 2008 Reduce Labor Supply? Evidence from Quantile Panel Data Estimation," Working Paper WR-710-3, Rand Corporation, (Santa Monica), March 2014. Observed price is an increasing function of the unobserved quality index.

Note that both theory and simulation studies suggest that confidence interval estimation in quantile regression models is best done with bootstrapped percentile confidence intervals with large numbers of replications, a technique that I employed to estimate 90 percent confidence intervals for these pass-through coefficients. *See* J. Hahn, "Bootstrapping Quantile Regression Estimators," Econometric Theory, Vol. 11, No. 1 (Mar., 1995), pp. 105-121; A. Karlsson, "Bootstrap Methods for Bias Correction and Confidence Interval Estimation for Nonlinear Quantile Regression of Longitudinal Data," Division of Statistics Research Report 2006:2, Uppsala University, Sweden, 2006, available at http://www.diva-portal.org/smash/get/diva2:130905/FULLTEXT01.pdf.

[84] Flamm II, ¶¶ 15-19, 169-179.

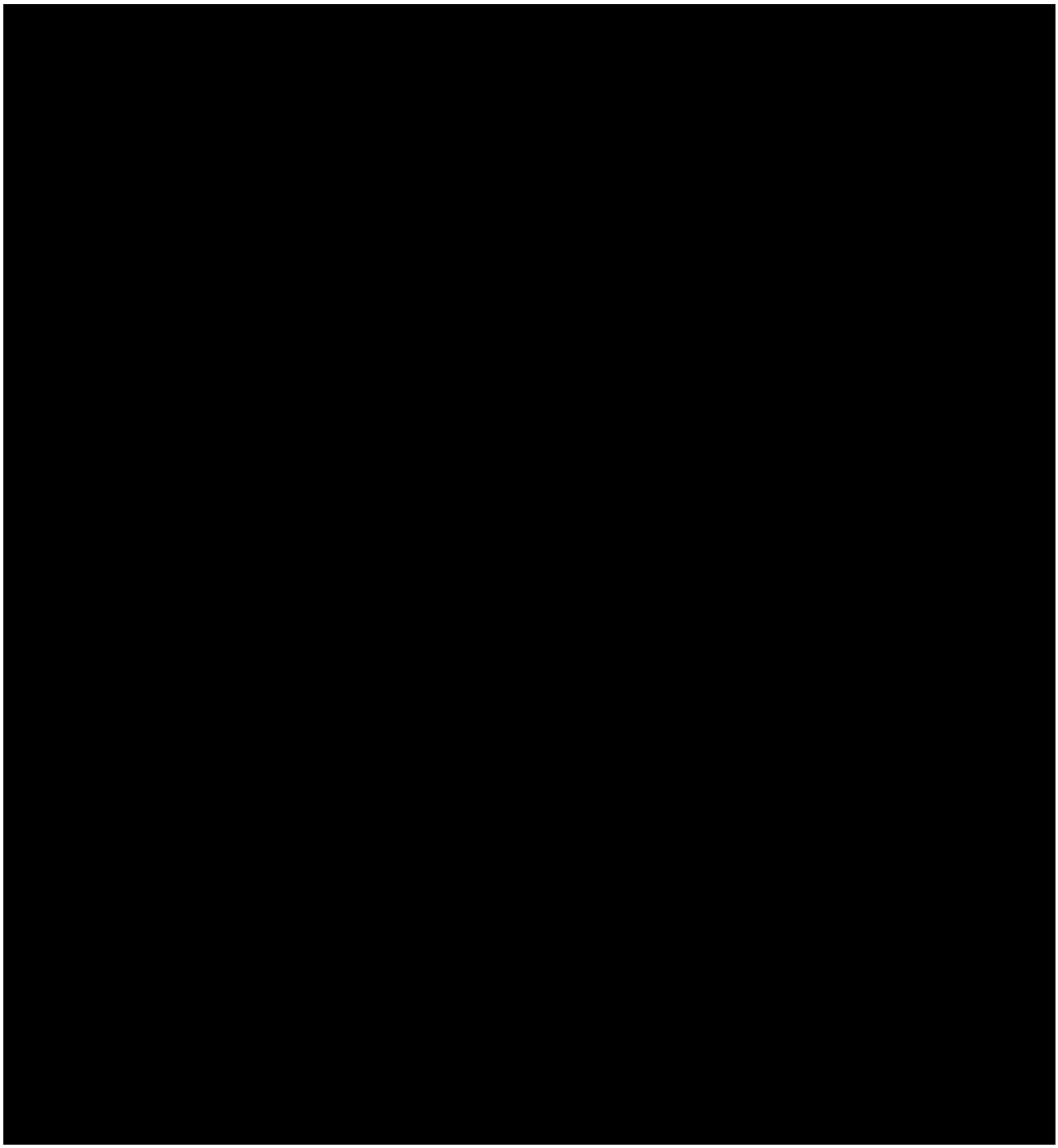
[85] Flamm II, ¶¶ 36-37, Ex. 3.

estimates of pass-through, as would be predicted based on the direction of bias for coefficients in linear models predicted with measurement error.[86]

166. Returning to the issue of heterogeneity in pass-through for computers sold at different price points, my fixed effect quantile regression model provides some useful answers. For [redacted] sales of desktop computers, and separately, for laptop computers, my regression model provides an answer to the question, if computer costs across the entire distribution of computer models at any moment in time were to generally increase by, say $5, how much would the price change for computers at the percentile for $299, compared with computers at the percentile selling for $999? I perform the quantile regression at eight percentiles of the distribution of monthly average prices, separated by $100, corresponding to prices from $299 through $999 in order to arrive at an answer [redacted]

[86] Note that both theory and simulation studies suggest that confidence interval estimation in quantile regression models is best done with bootstrapped percentile confidence intervals with large numbers of replications, a technique that I employed to estimate 90 percent confidence intervals for these pass-through coefficients. Hahn, Jinyong, "Bootstrapping Quantile Regression Estimators," Econometric Theory, Vol II, No. 1 (1995), pp. 105-121.

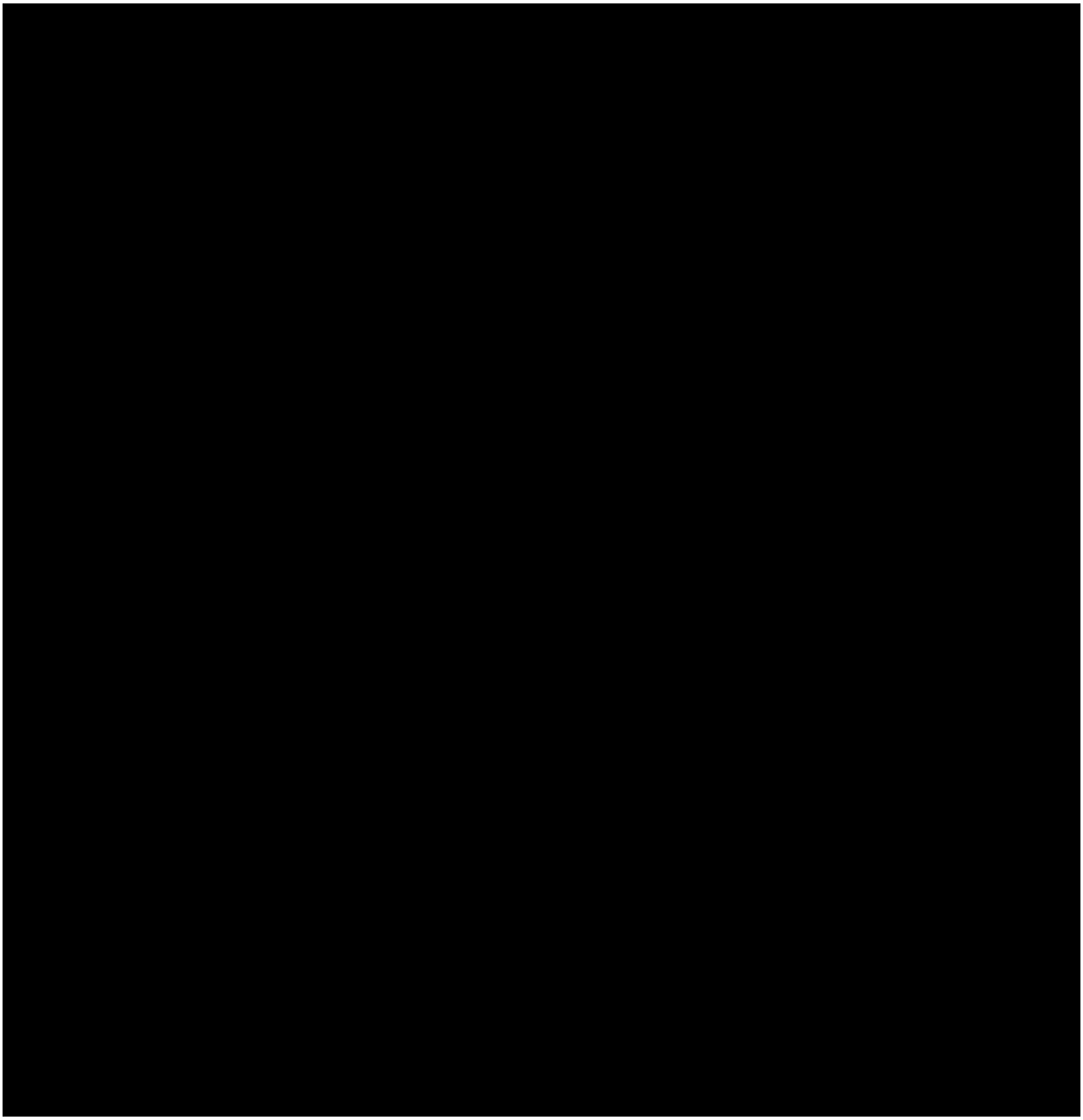
Table 6: Pass-Through at Different Computer Prices (Quantile Regression)



167. At all the illustrative percentiles analyzed, there was statistically significant positive pass-through, generally exceeding 100 percent. **Table 7** demonstrates that with weekly instead of monthly average prices by model (and weekly time indicator variables), the point estimates were generally a little lower, behavior consistent with the statistical theory of measurement error, and

validating concerns that bias due to measurement error was likely to be larger with weekly averages than monthly averages:

Table 7: Effects of Measurement Error (Quantile Regression) – Not Averaging Data by Month Increase Attenuation Bias



168. In short, I have performed a variety of analyses to examine the issue of pass-through of cost into price. The analyses have separately analyzed cost changes "baked-in" to the initial price for the configuration sold at some particular price point for preconfigured computers (my hedonic

analyses of pass-through for OEM standard cost, and "baked in" initial purchase cost pass-through for the three different retailers, shown in this report), the pass-through of ongoing cost changes into preconfigured computers after their first sales launch (my fixed effect analysis of ongoing retailer cost pass-through in my previous reports), the pass-through of initial and ongoing costs into CTO computers (the Dell hedonic pass-through analysis in my previous reports), and my quantile regression analysis of pass-through at different price-points for [redacted] laptop and desktop computers.

b. Additional Analysis of Pass-Through at the Distributor Level

169. It is my understanding that Synnex is a direct action plaintiff in this MDL. Synnex produced additional data in response to a third party subpoena by indirect purchaser plaintiffs on February 13, 2015. Synnex is a large distributor of peripherals, IT systems, storage solutions, system components, software, and networking equipment, among other things.[87]

170. The files produced by Synnex include over 4.5 million observations which were screened to exclude observations representing non-ODD products or unwanted records. After applying screens, the data were collapsed into 94,590 monthly observations for 22,481 model numbers.

171. Synnex's estimated pass-through rate is presented in **Exhibit 12**. Lagged cost estimates are selected for all three product categories. The estimate for desktop computers is [redacted] percent, which is not statistically different from [redacted] percent. The estimates for both laptop computers and drives are [redacted] percent, and both are statistically significantly greater than [redacted] percent.

c. Summary of Pass-Through Results

172. All these varied analyses of different data sets from different computer producers and retailers produce essentially the same answer: substantial positive rates of pass-through, generally at or above 100 percent of cost changes. The conclusion that these methods are capable of demonstrating pass-through, and therefore impact, is unassailable. Further, the demonstrations of

[87] *See* Synnex, About Synnex, *available at* http://www.synnex.com/about_SYNNEX/CoreCompetencies.html.

these methods contained in this and previous reports concur in painting a coherent picture of impact across the entire class of purchasers of ODD products.

173. In my original set of reports to this Court, I empirically analyzed pass-through using datasets from 19 companies for more than 194 million ODD products spanning seven years. Using the same regression model for all products and channels, I measured dozens of different pass-through rates ranging from 64 to 151 percent:[88] In most cases, estimated standard errors were sufficiently large such that I could not reject a pass-through of 100 percent, as would be predicted in a highly competitive market. In all cases, estimated standard errors were small enough such that I could reject a pass-through rate of zero, as would have to be the case for the alleged collusion to have no impact on consumers.

174. I have now measured pass-through rates for over 273 million ODD products. This total includes additional analysis at the OEM level for [redacted] **Table 8** summarizes the results:

[88] *See* Flamm II., App. A (Exhibit 1: Summary of Pass-Through).

Table 8: Summary of Pass-Through Rates

	Pass-Through Rate Summary[1]					
	Desktops		Laptops		Drives	
I. Computer OEM	Pass-through	Rev ($M)[2]	Pass-through	Rev ($M)[2]	Pass-through	Rev ($M)[2]
[redacted]						
NEC	n/a		n/a		68%	3,654
Panasonic	n/a		n/a		98%	442
[redacted]						
II. Distributor						
Ingram	103%	3,533	101%	6,964	104%	271
SED	103%	67	125%	172	83%	28
[redacted]						
III. Retail						
[redacted]						
Best Buy	99%	8,823	113%	15,202	104%	538
CompUSA	n/a		92%	7,969	n/a	
Fry's	77%	437	116%	1,614	118%	582
[redacted]						
Newegg	85%	100	64%	385	105%	88
Office Depot	n/a		n/a		118%	38
OfficeMax	n/a		n/a		96%	31
PC Connection	94%	673	92%	1,324	102%	35
[redacted]						

Notes
1. See PassThrough_Table_and_Exhibits.xlsx.
2. Sample revenues from produced data.
3. For average pass-through rates by product and channel, see the Appendix.

175. This pass-through analysis used the fixed effects and hedonic regression models described in my report for each measurement and includes companies that represent retail store types that cover 79.8 percent of personal computer retail sales and 45.1 percent of top distributor sales. *See* **Appendix Exhibit A.6** and backup to the Appendix.

d. Given The Multiple Methods Used to Test Pass-Through and the Wide Application of These Methods, Impact is Common to the Class

176. The studies listed above show that elevation in the cost of ODDs would have led to a market-wide increase in the quality-adjusted price of ODD products. The studies of pass-through I performed on retailers, in addition to demonstrating the wide applicability of the methodology I have employed, also show that at a minimum, in the approximately 60 percent of retail US ODD product sales accounted for by these retailers, impact was felt. *See* backup to the Appendix.

177. What of the remaining 60 percent of the retail market? To begin, there is no reason to believe that the remaining retailers would be any different than the retailers studied, since the

market PC is a highly integrated market in the US, with competition felt across retail channels throughout the country. Best Buy, for example, during the early part of the class period, during which it primarily sold ODD products through brick and mortar stores scattered around the country, testified that its primary competitor was the online retail operations of OEM Dell. Similarly, online only vendor Amazon sells computers that are sold and shipped to every nook and cranny of the U.S. market.

178. Economic theory suggests that in this sort of highly integrated market, prices are linked by substitution among end user buyers, across retail outlets, and that retailers in turn, will substitute among OEMs in seeking out the most price competitive ODD products that they can find to offer buyers. Similarly, OEM computer manufacturers will substitute among commodity drives offered by different ODD producers in order to reduce their costs and offer more price- and feature-competitive ODD products. Finally, ODD producers, when acting competitively, substitute among ODD drive types and features on their manufacturing lines in order to produce the most profitable product mix.

* * *

I declare under penalty of perjury under the laws of the United States that the foregoing is true and correct. Executed this 20th day of May 2015, at San Francisco, California.

DR. KENNETH FLAMM

CURRICULUM VITAE

KENNETH S. FLAMM

CURRENT POSITION

Professor and Dean Rusk Chair in International Affairs, University of Texas at Austin. Director, Technology, Innovation, and Global Security Program, The Strauss Center on International Security and Law, the University of Texas at Austin. Fields of specialization: economic analysis of innovation in high technology industries; science and technology policy; international economics; technology modeling; applied econometrics; the computer, semiconductor, and internet industries; defense economics.

CURRENT RESEARCH

Determinants of innovation in semiconductors, computers, and telecommunications; economics of Internet use and deployment; the economic analysis of R&D, technology, and technology policy.

PREVIOUS POSITIONS

1995 to 1998, Senior Fellow, The Brookings Institution

1994 to 1995, Special Assistant to the Deputy Secretary of Defense (Dual Use Technology Policy) and Principal Deputy Assistant Secretary of Defense (Economic Security)

1993 to 1994, Acting Assistant Secretary of Defense (Economic Security), Principal Deputy Assistant Secretary of Defense and Special Assistant to the Under Secretary (Dual Use Technology Policy and International Programs)

1990 to 1998, Adjunct Professor, Department of Economics, The George Washington University.

1987 to 1993, Senior Fellow, The Brookings Institution.

1979 to 1987, Research Associate, The Brookings Institution.

1984 to 1989, Professorial Lecturer, Department of Economics, The George Washington University.

1979 to 1985, Assistant Professor, Department of Economics, University of Massachusetts, Amherst.

1979, Instructor of Economics, Clark University.

1978, Teaching Assistant, microeconomics, M.I.T.

1978, Economic Advisor, Directorate of Income Policy, Ministry of Finance and Public Credit, Mexico.

1977-78, Associate Professor, Department of Economics, Instituto Tecnologico Autonomo de Mexico.

1976, Teaching Assistant, econometrics, M.I.T.

1975-76, Research Assistant, World Oil Model, Energy Laboratory, M.I.T.

EDUCATION

Ph.D., Economics Massachusetts Institute of Technology, 1979
A.B. (Honors), Economics, Stanford University, 1973

HONORS and AWARDS

Danforth Graduate Fellowship (selected 1973)
Phi Beta Kappa (elected Junior year, 1972)
National Merit Scholar (selected 1969).
Myers Prize for Best Honors Thesis in Economics, Stanford University, (1973)
U.S. Department of Defense, Distinguished Public Service Medal, (awarded by Secretary of Defense, 1995)

MEMBERSHIPS

Senior Research Fellow, IC^2 Institute, The University of Texas at Austin.

Board on Science, Technology, and Economic Policy, National Research Council

Chair, Committee on Intangible Assets: Measuring and Enhancing Their Contribution to Corporate Value and Economic Growth, National Research Council

Vice Chair, Committee on Comparative Innovation Policy: Best Practice in National Technology Programs, National Research Council

Committee on the Rationale and Goals of the U.S. Civil Space Program, National Research Council

Committee on the Future of Supercomputing, National Academy of Sciences, Computer Science and Technology Board

Committee on Capitalizing on Science, Technology, and Innovation: An Assessment of the Small Business Innovation Program, National Academy of Sciences.

Steering Group on Measuring and Sustaining the New Economy, National Research Council

Chair, NATO Science Committee Panel for Science and Technology Policy and Organization.

Economics of Innovation and New Technology, Editorial Board.

Federal Networking Council Advisory Committee.

National Research Council Steering Group on Government-Industry Partnerships.

National Research Council Steering Group on Measuring and Sustaining the New Economy.

Roundtable on the Geo Economics of Military Preparedness, Council on Foreign Relations.

Study Group on Consolidation, Downsizing, and Conversion in the U.S. Military Industrial Base, Council on Foreign Relations.

Study Group on American Commercial Diplomacy in Asia, Council on Foreign Relations.

Study Group on Defense Industry Globalization, Conversion, and the Arms Trade, Council on Foreign Relations.

Study Group on Consolidation, Downsizing, and Conversion in the U.S. Military Industrial Base, Council on Foreign Relations.

Advisory Committee, Center for Innovation Policy Research, Budapest, Hungary.

Defense Science Board Task Force on International Arms Cooperation.

Defense Science Board 1995 Summer Study.

Advisory Panel on Information Technology and Research, Advisory Panel on Multinational Firms and the U.S. Technology Base, Office of Technology Assessment, U.S. Congress.

Panel on the Federal Role in the Commercialization of Technology, National Research Council.

Expert Advisory Panel, National Science Board Committee on Industrial Support for R&D.

National Science Foundation Advisory Committee on Data and Policy Analysis.

Expert Working Party on High Performance Computers and Communications, Organization for Economic Cooperation and Development.

Co-chair, Task Force on the Federal Role in Commercialization of New Technology; Member, Trade and Investment Advisory Committee, Council on Competitiveness.

Referee:
Quarterly Journal of Economics, Journal of Industrial Economics; Rand Journal of Economics; Review of Economics and Statistics, International Economic Journal; Research Policy; Journal of Development Economics; Journal of International Economics; Science; Growth and Change; International Organization; World Development, Telecommunications Policy, Structural Change and Economic Dynamics.

Consultant (Public Sector):
National Academy of Science; World Bank, Development Research, Industry Departments; U.S. Congress, Office of Technology Assessment; Latin American Economic System; Organization for Economic Cooperation and Development; U.S. Agency for International Development; U.S. Department of Justice; U.S. Department of Defense; Mexico, Ministry of Finance.

Testimony before U.S. Congress, including Joint Economic Committee; Senate Governmental Affairs Committee; House Committee on Space, Science and Technology; House Subcommittee on Telecommunications; House Armed Services Committee; House Appropriations Committee; U.S. International Trade Commission; U.S. Department of Commerce; Federal Accounting Standards Advisory Board; Superior Court, San Francisco, California; Federal Courts: Eastern District of Pennsylvania, Western District of Texas, Eastern District of Texas, Northern District of California.

PERSONAL DATA	Born: Rio de Janeiro, Brazil Citizenship: United States
	Complete fluency in Spanish; reading knowledge of French, Italian, Portuguese; elementary Japanese.
GRANTS AS PRINCIPAL, CO-PRINCIPAL INVESTIGA-TOR, LAST 10 YEARS	Texas Connects Coalition & Technology for All, "Digital Inclusion," 2012-2013
	National Science Foundation, "Modeling Pharmaceutical Innovation Pipelines," 2010-2012
	National Science Foundation, "Modeling Innovation Chains Using Case-Based Econometrics: Nano-electronics and Biotechnology Applications," 2008-2012
	Congressional Research Service, Library of Congress, "Winning the Globalization Game: How Countries Compete in the 21st Century," 2007-2008
	"Semiconductor Industry Economics," Kauffman Foundation, 2006-2008.
	Congressional Research Service, Library of Congress, "Changing Modes of Defense Procurement: Implications for Pricing and Innovation in the US Defense Industry," 2005-2006.
	National Science Foundation, "Internet Use in the Americas," 2004-2006.
	Ford Foundation, Hewlett Foundation, "An Experiment in Cooperative Policy Research: Normalizing Inter-American Relations with Cuba," 2003-2006.
	Congressional Research Service, Library of Congress, "Broadband Policy in Comparative International Perspective," 2004-2005.
	Rockefeller Foundation, "Researching the Economic Implications of Fair Use," 2002-2004.
	Congressional Research Service, Library of Congress, "Exploring the Digital Divide: Regional Differences in Patterns of Internet Use in the United States," 2003-2004.
	SEMATECH International, "Improving Semiconductor Industry Models," 2002-2003.

Congressional Research Services, Library of Congress, "Internet Use in Developing and Industrializing Countries," 2002-2003.

Pew Internet and American Life Project, "Determinants of Internet Use by US Households," 2002-2003.

PUBLICATIONS

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(with S. Nagaoka, M. Kondo, and C. Wessner, Ed)., 21st Century Innovation Systems for Japan and the United States: Lessons from a Decade of Change, (Washington: National Academies Press), 2009.

(with others), Committee on the Rationale and Goals of the U.S. Civil Space Program), America's Future in Space: Aligning the Civil Space Program with National Needs, (Washington: National Academies Press), 2009.

(with others), Committee on the National Defense Stockpile, National Research Council, Managing Materials for a 21st Century Military, (Washington: National Academies Press), 2007.

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Mismanaged Trade? Strategic Policy and the Semiconductor Industry, (Washington: Brookings Institution), 1996.

Changing the Rules: Technological Change, International Competition and Regulation in Communications, (with Robert Crandall, ed.), (Washington: Brookings Institution), 1989.

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EXHIBIT 2

MATERIALS RELIED UPON BY DR. KENNETH FLAMM IN PREPARATION OF HIS SUPPLEMENTAL DECLARATION

A. Documents

See also In re the Matter of Sony Optiarc Inc.'s Violation of the Fair Trade Act, (May 16, 2013) (Exhibit 137 to the Declaration of Jeff D. Friedman in Further Support of Indirect Purchaser Plaintiffs' Motion for Class Certification ("Friedman Reply Decl.") (dated February 18, 2014);

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B. Testimony

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DELL-ODD-00223740
DELL-ODD-00255056
DELL-ODD-00265622
SEC-ODD-00000004
ODD-HP133202
ODD-HP140820
ODD-HP148173
ODD-HP026715
ODD-HP151746
ODD-HP155989
ODD-HP170701
ODD-HP170840
ODD-HP170846
ODD-HP170854
ODD-HP177074
ODD-HP201223
ODD-HP269714
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HLDS_CIV17015421- 25
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PNA-CIV0000377455
PNA-CIV0000377457
Q000003118
Q000003117
Q000003124
Q000003125
Q000003677
ODD-BENQ-00061018

D. Court Documents

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Declaration of Dr. Kenneth Flamm in Further Support of Indirect Purchaser Plaintiffs' Motion for Class Certification, filed Under Seal, Feb. 18, 2014.

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Exhibit 3

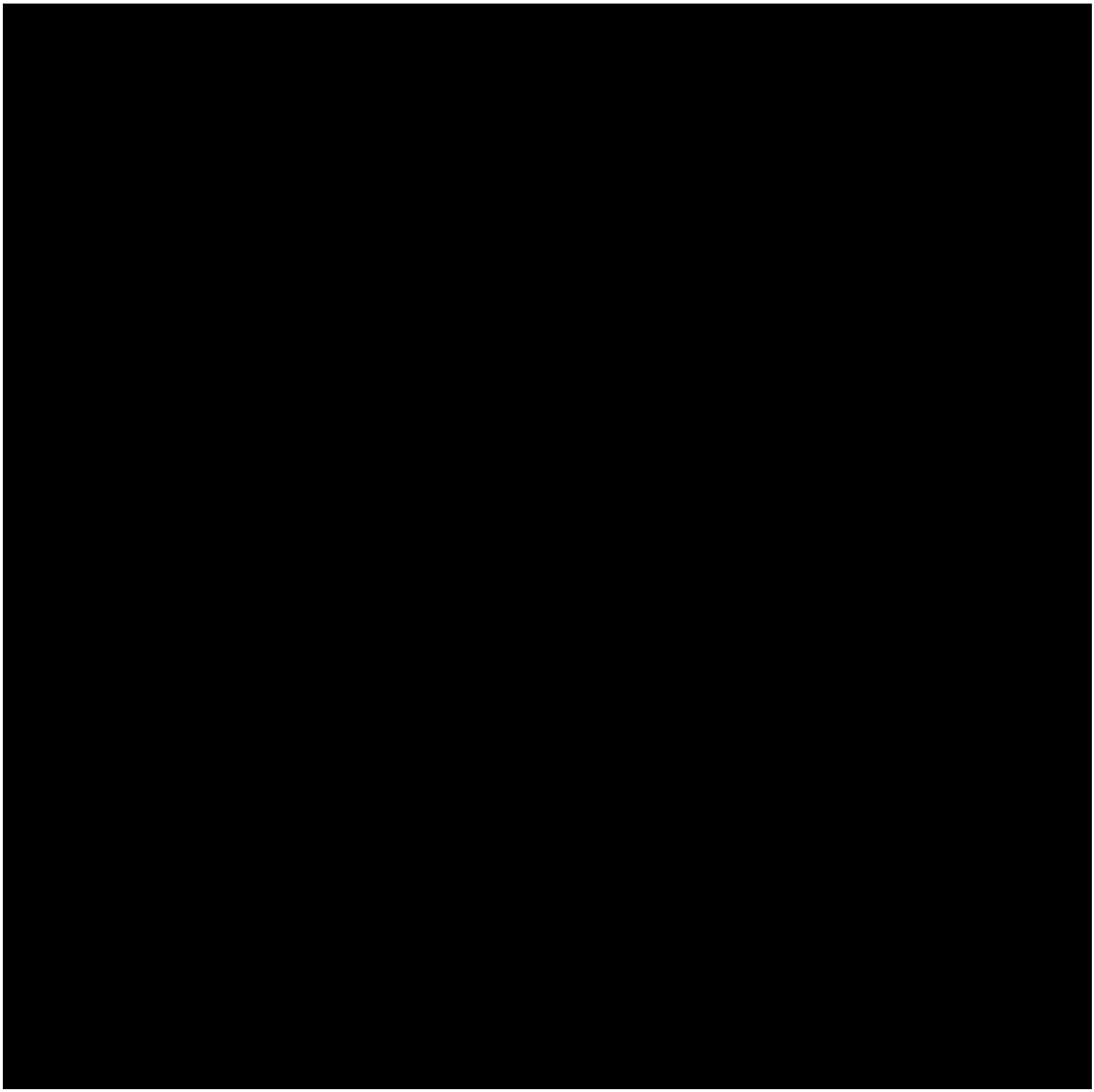
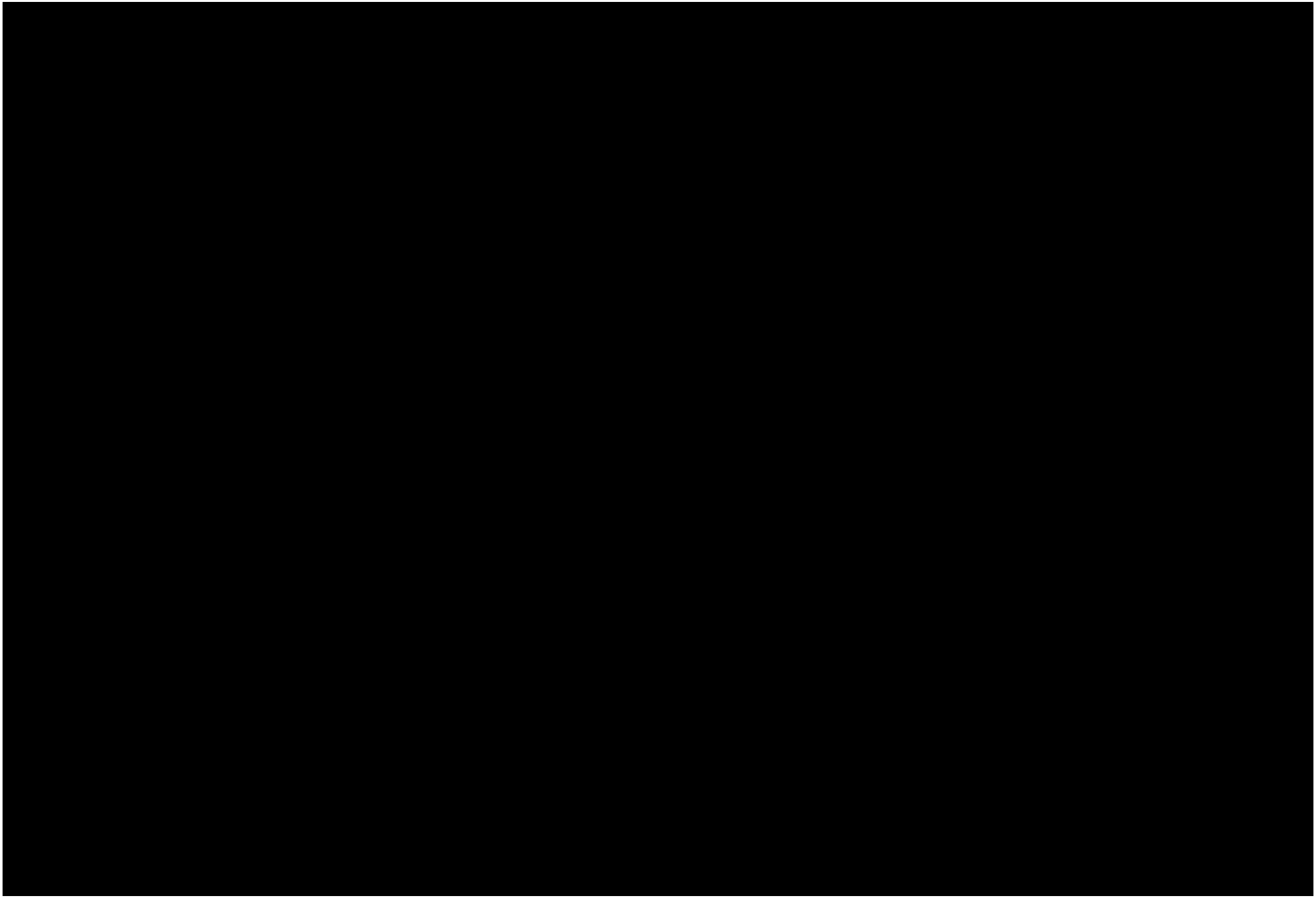


Exhibit 4



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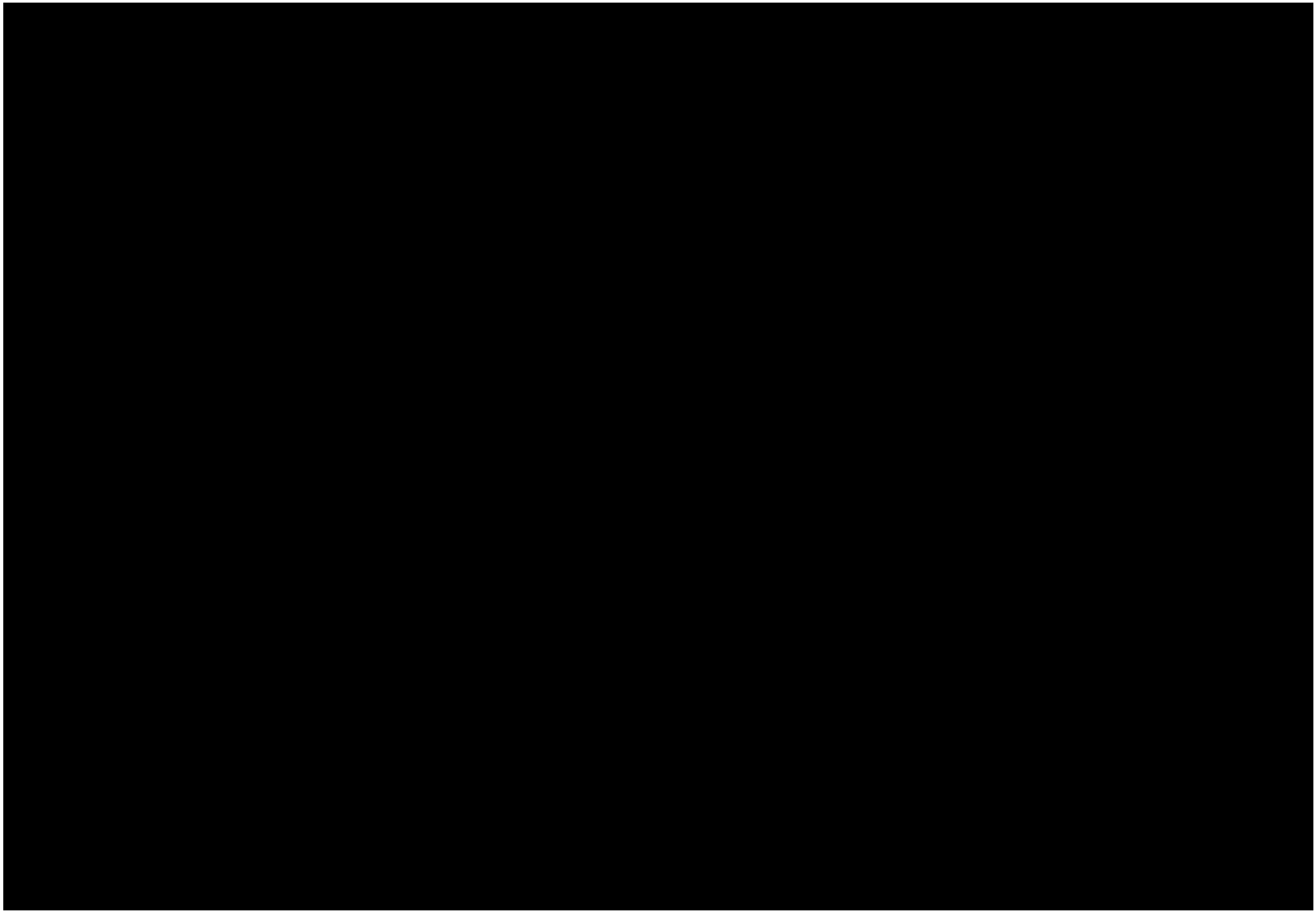


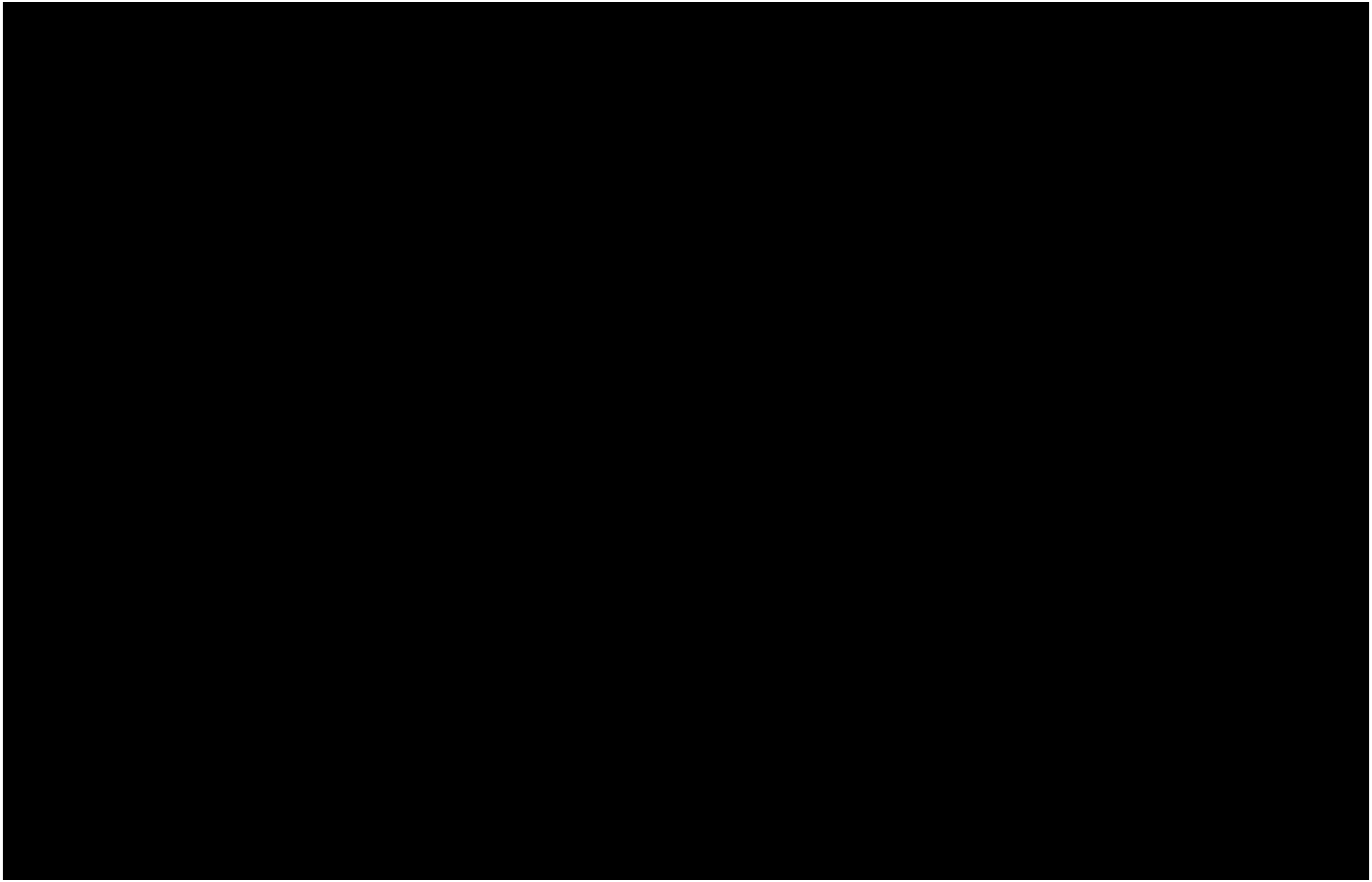


Exhibit 6B

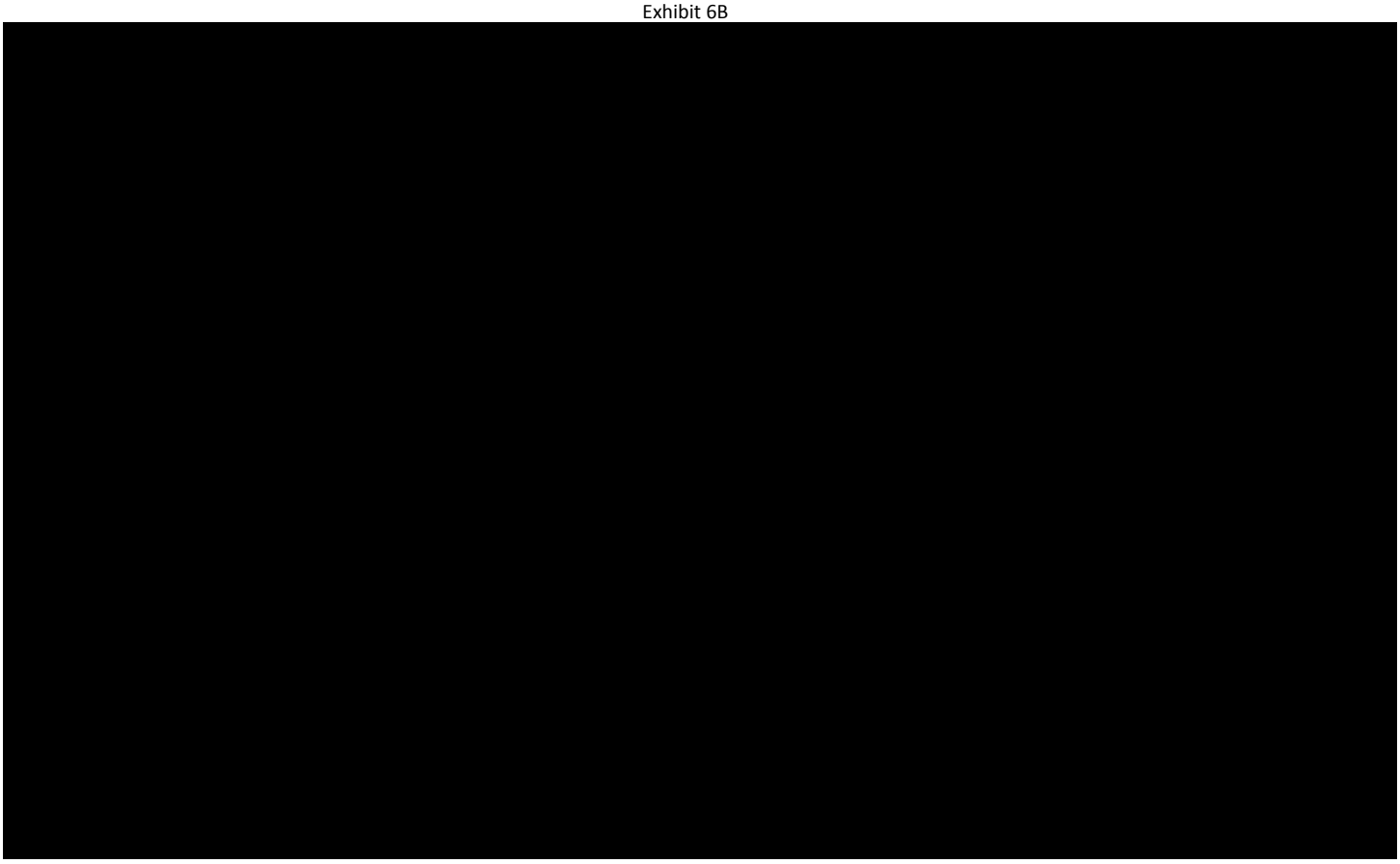
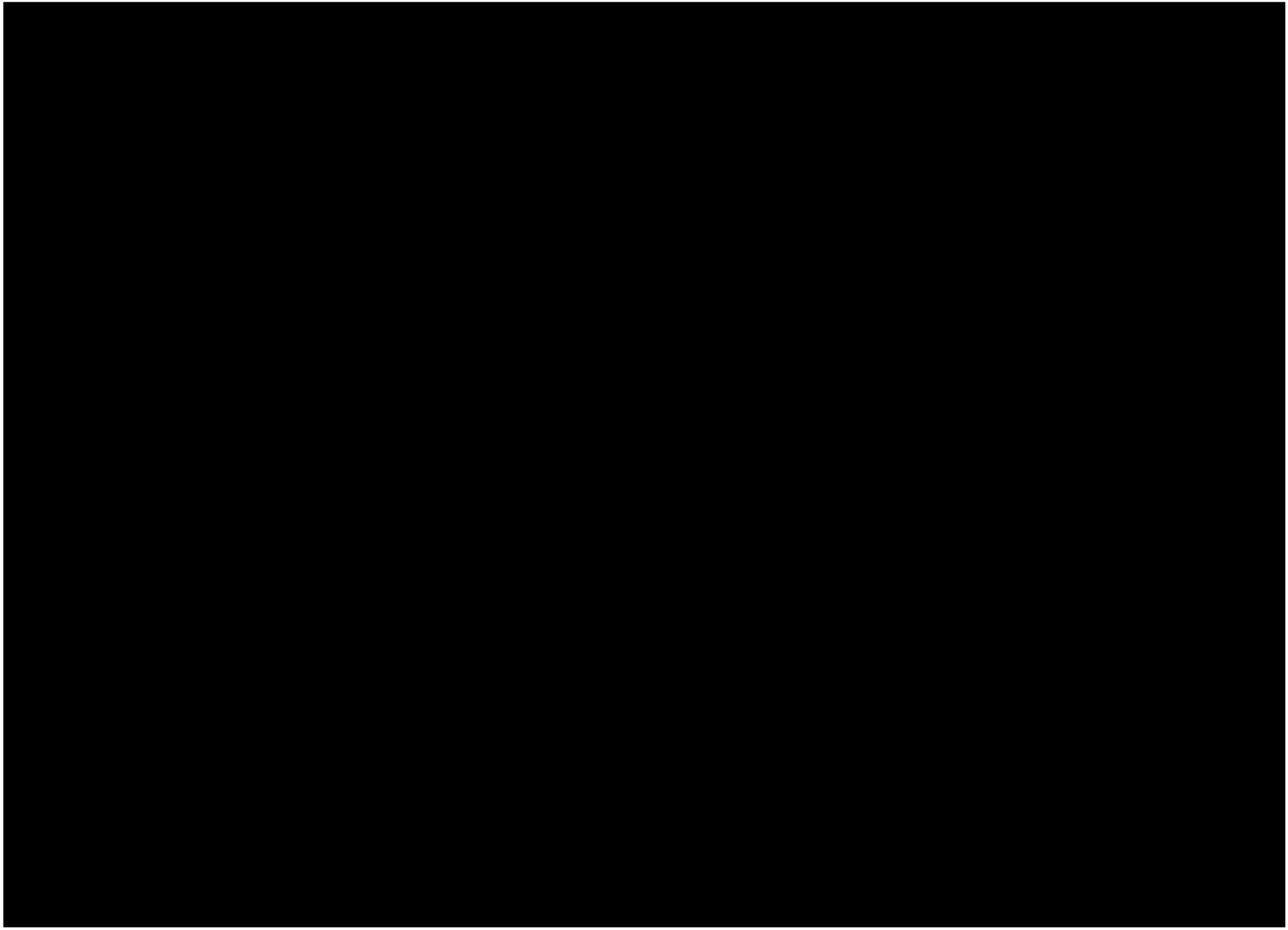


Exhibit 6D

Exhibit 6E



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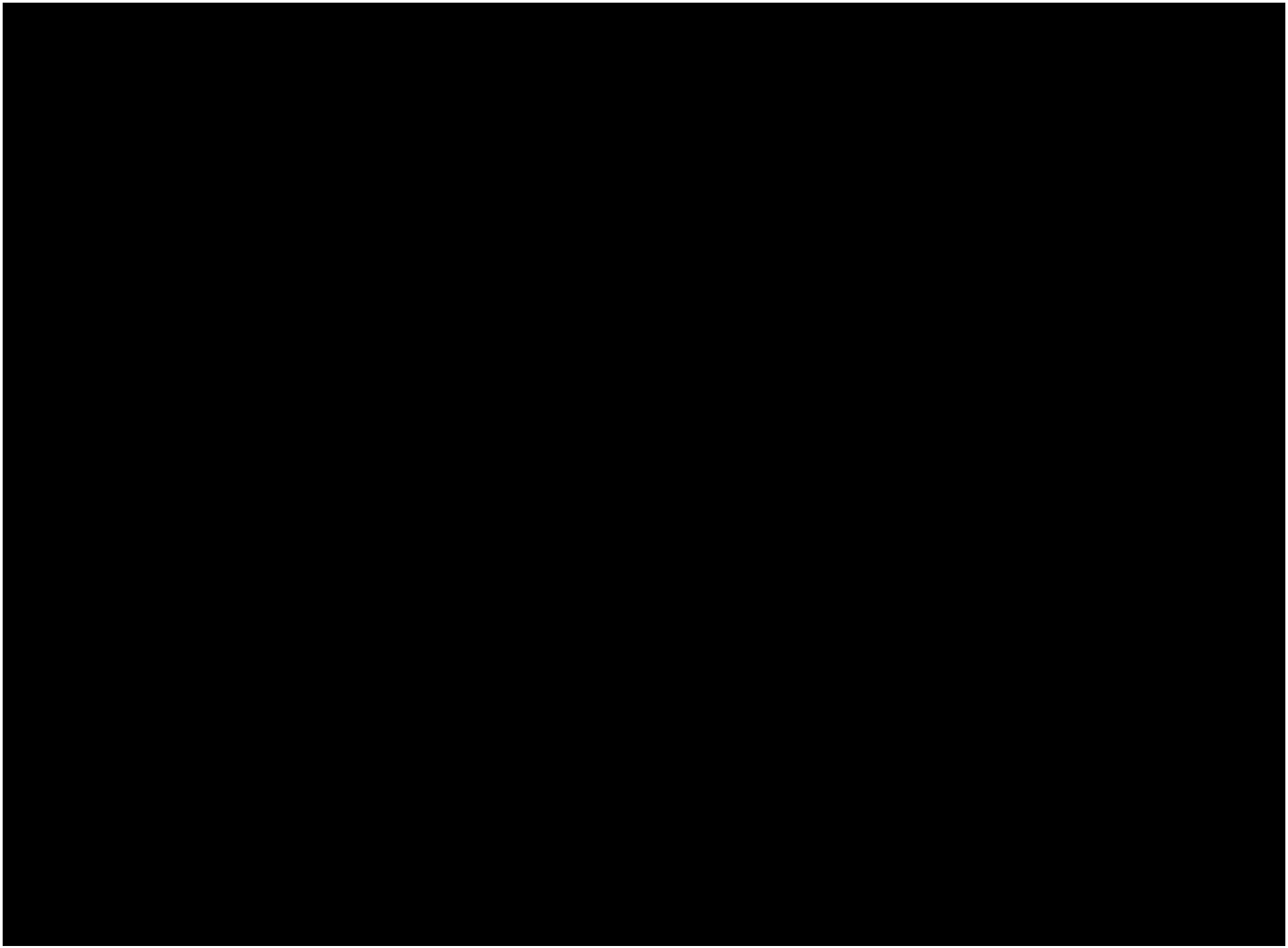

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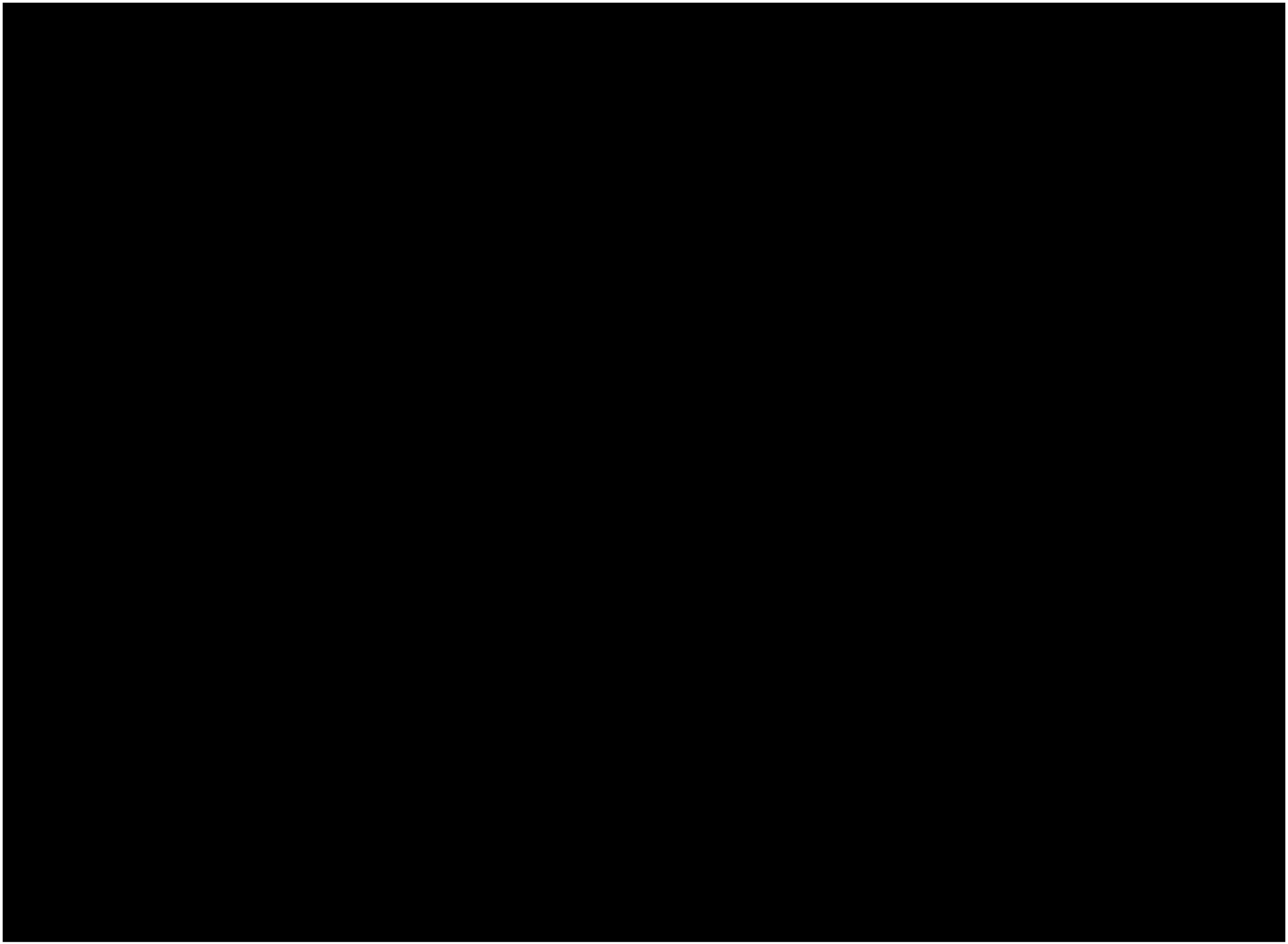


Exhibit 6H

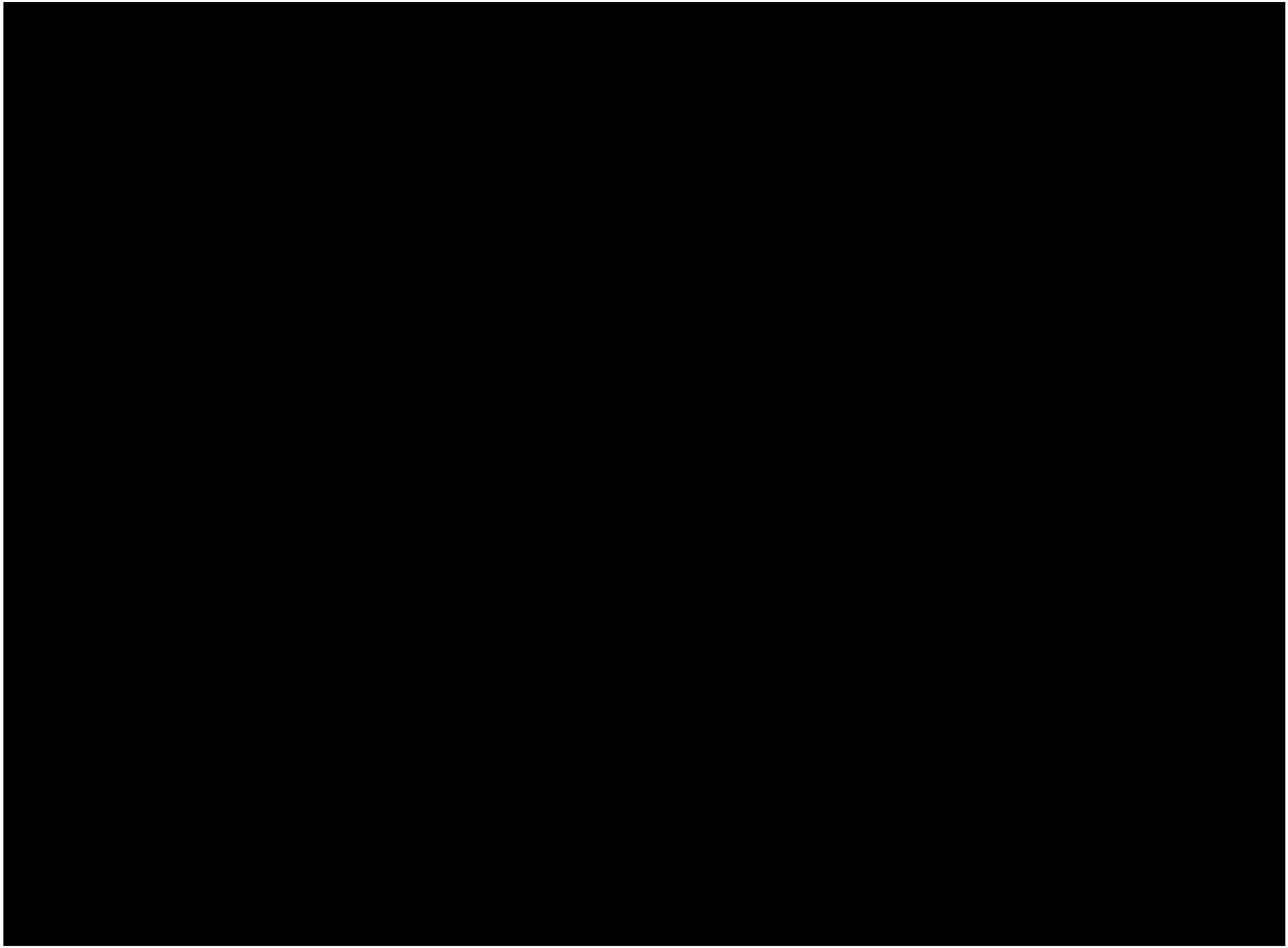


Exhibit 7A
Acer Pass Through to Retailers

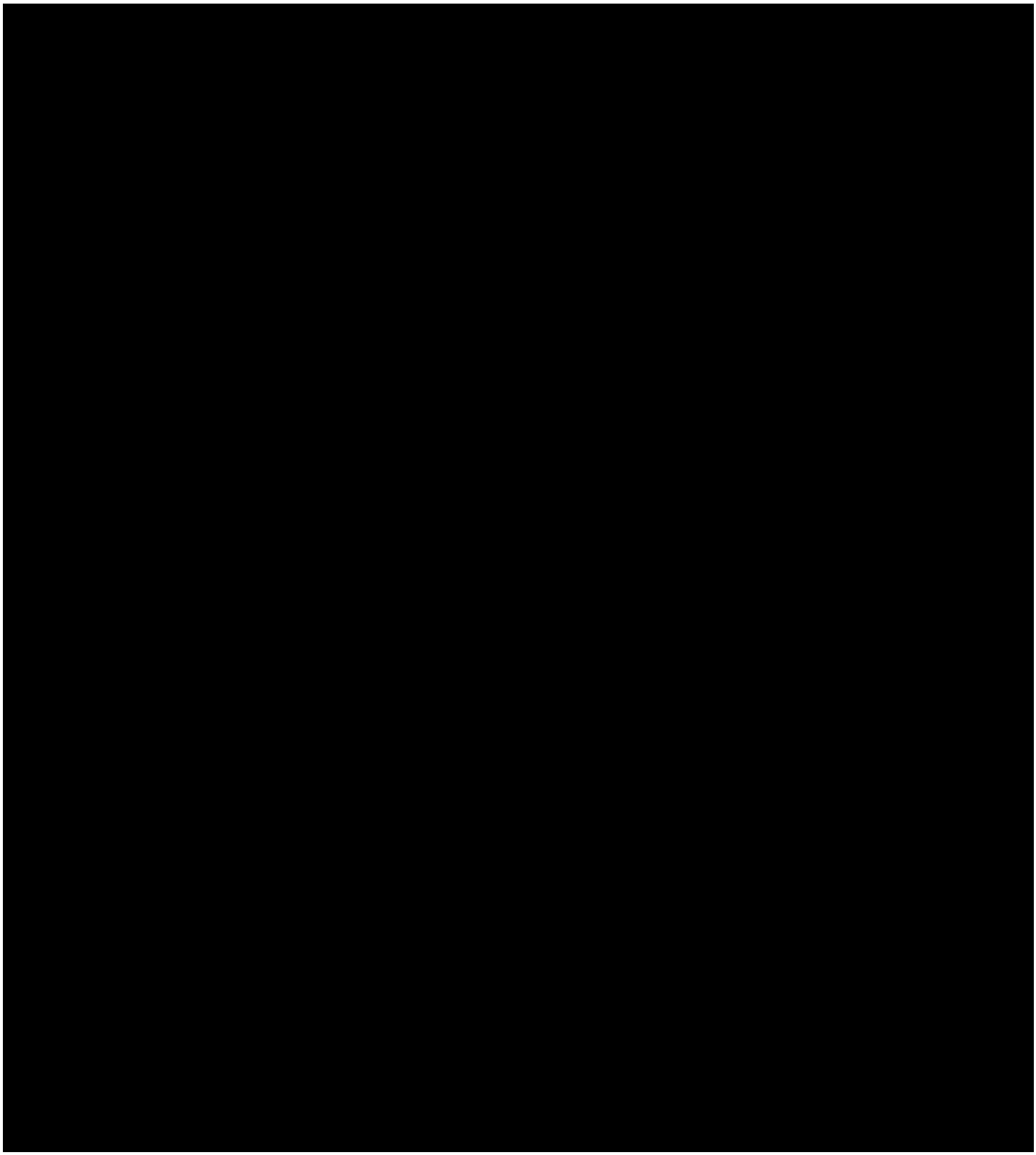


Exhibit 7B
Acer Pass-Through to Non-Retail[1]

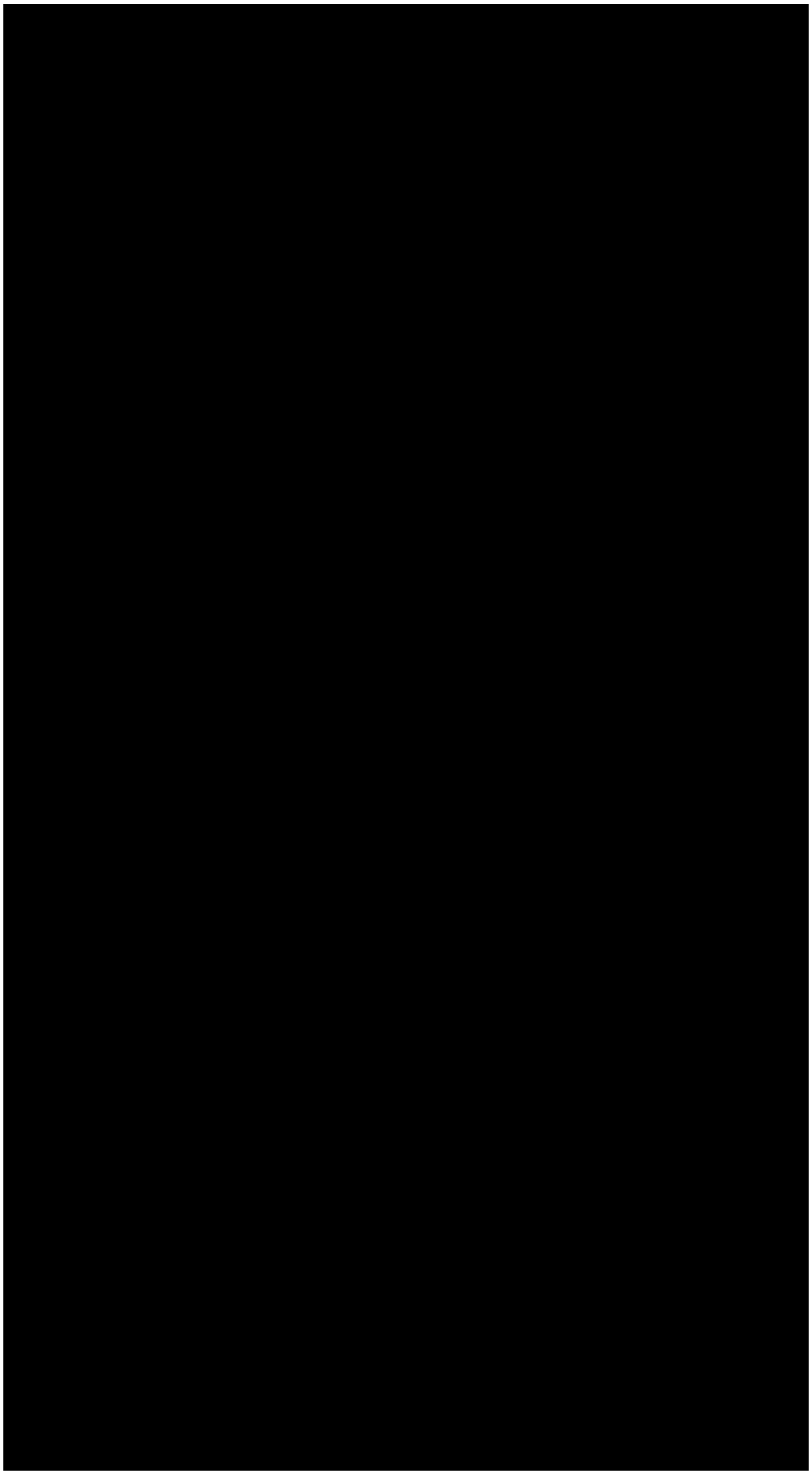


Exhibit 7C
Updated Dell Computer Pass-Through[1]

Exhibit 7D

Dell Pass Through to Retailers[1]

[redacted]

Exhibit 7E

HP Pass Through to Retailers[1,2]

Exhibit 7F

HP Pass Through for Direct to Consumer Sales[1]

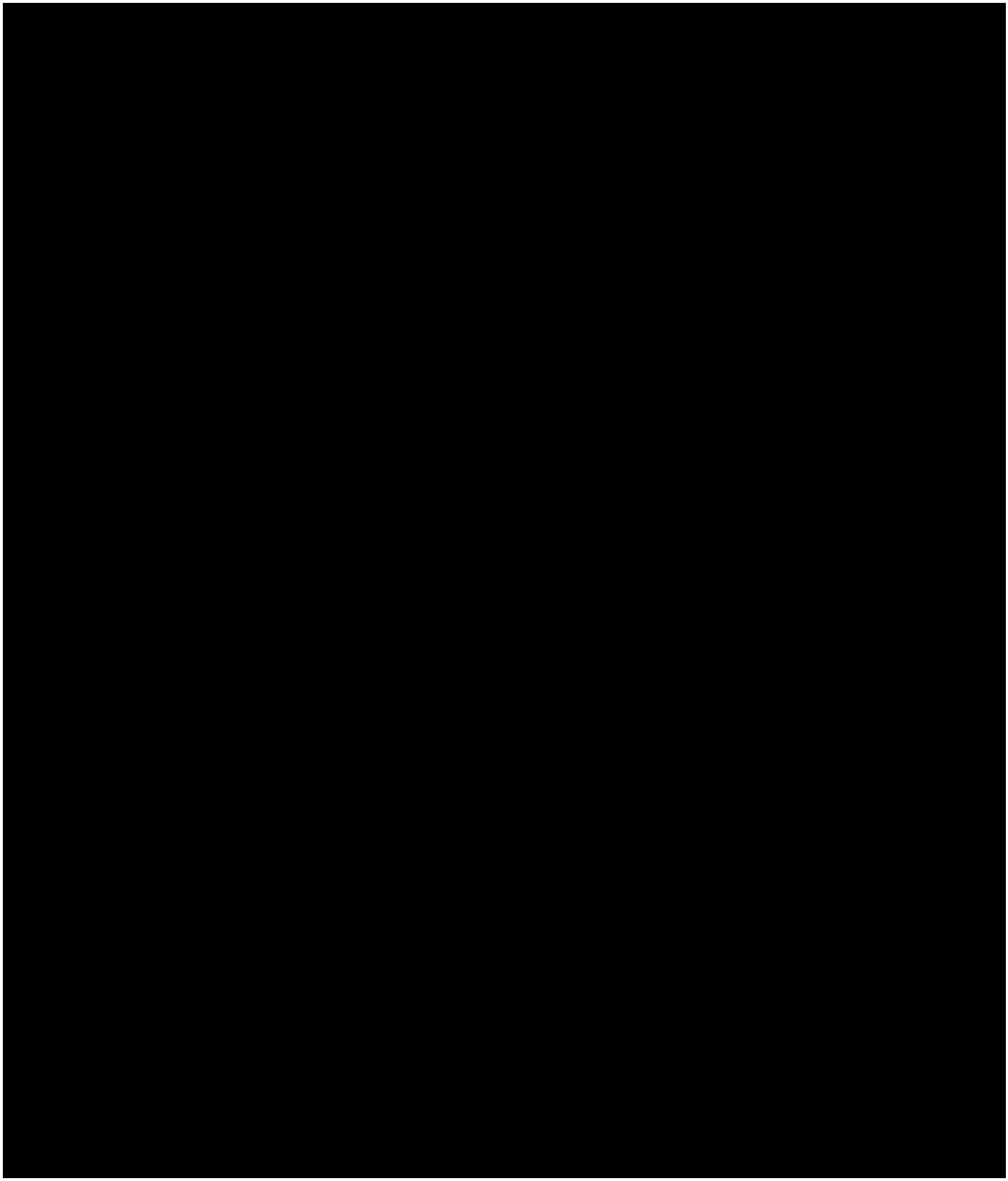


Exhibit 7G
Toshiba Laptop Pass Through to Retailers

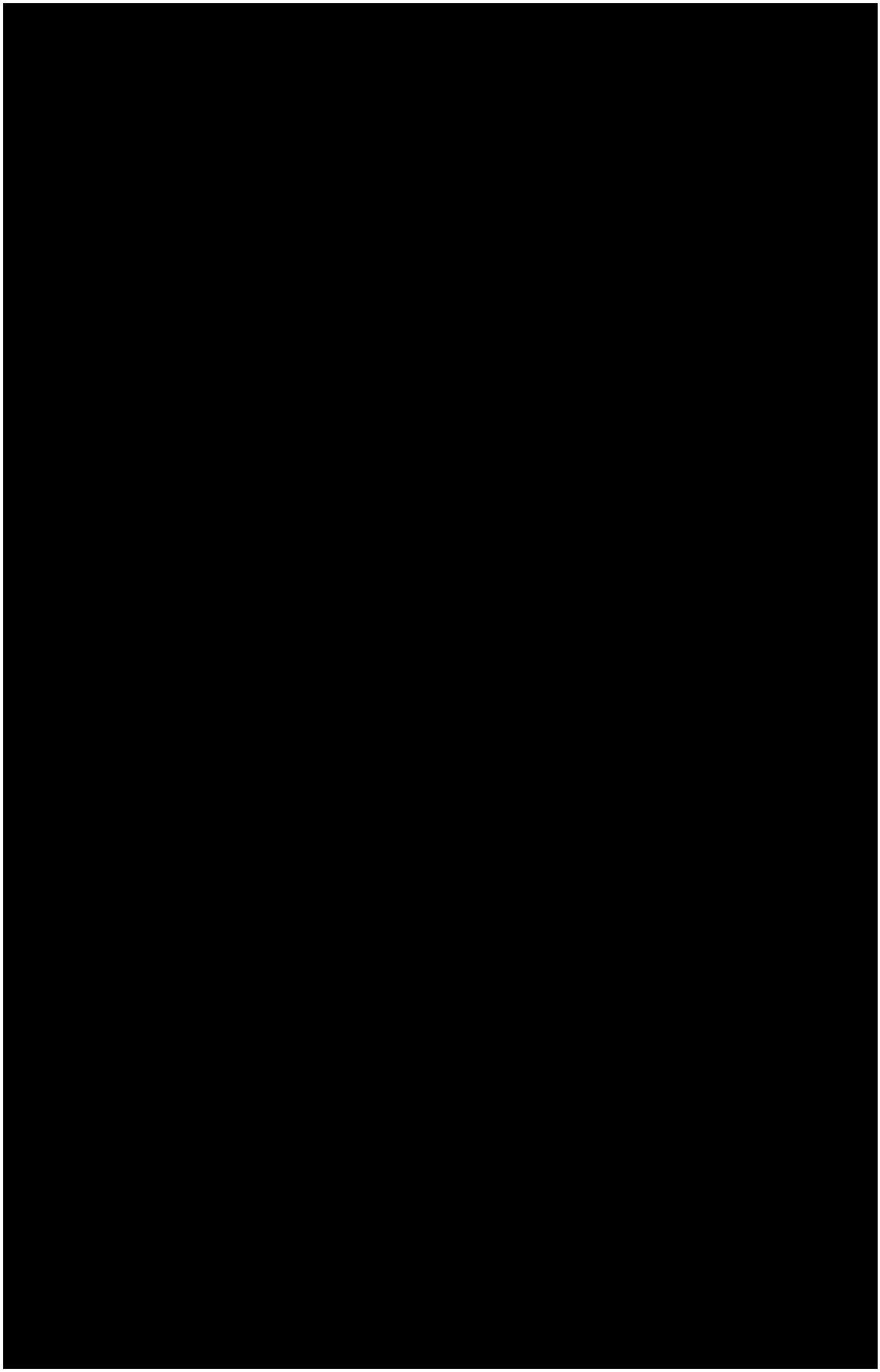


Exhibit 8A
Best Buy Passed Through Introductory Costs, Including the Costs of Products Sold at Price Points, Desktops

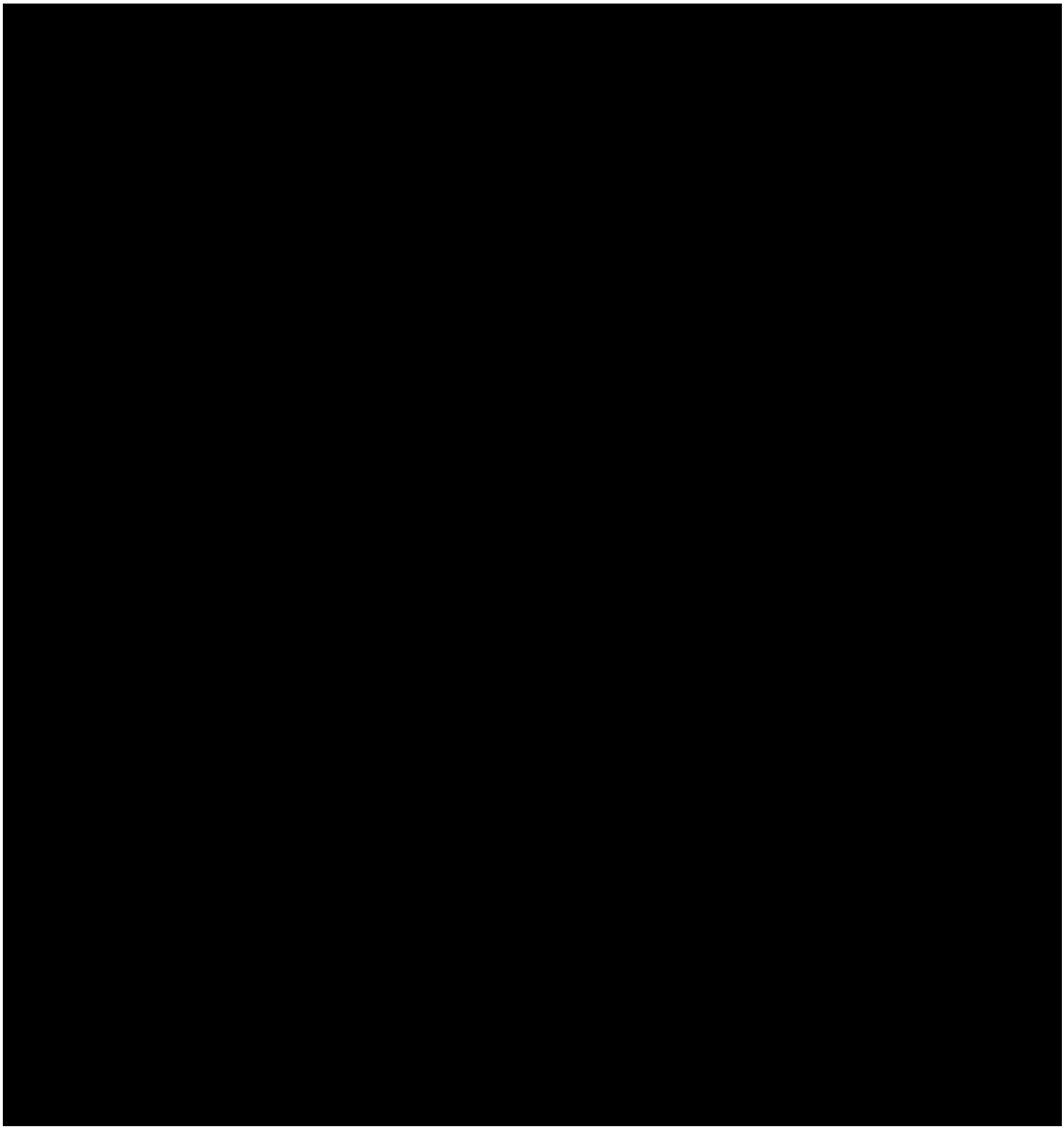


Exhibit 8B
Best Buy Passed Through Introductory Costs, Including the Costs of Products Sold at Price Points, Laptops

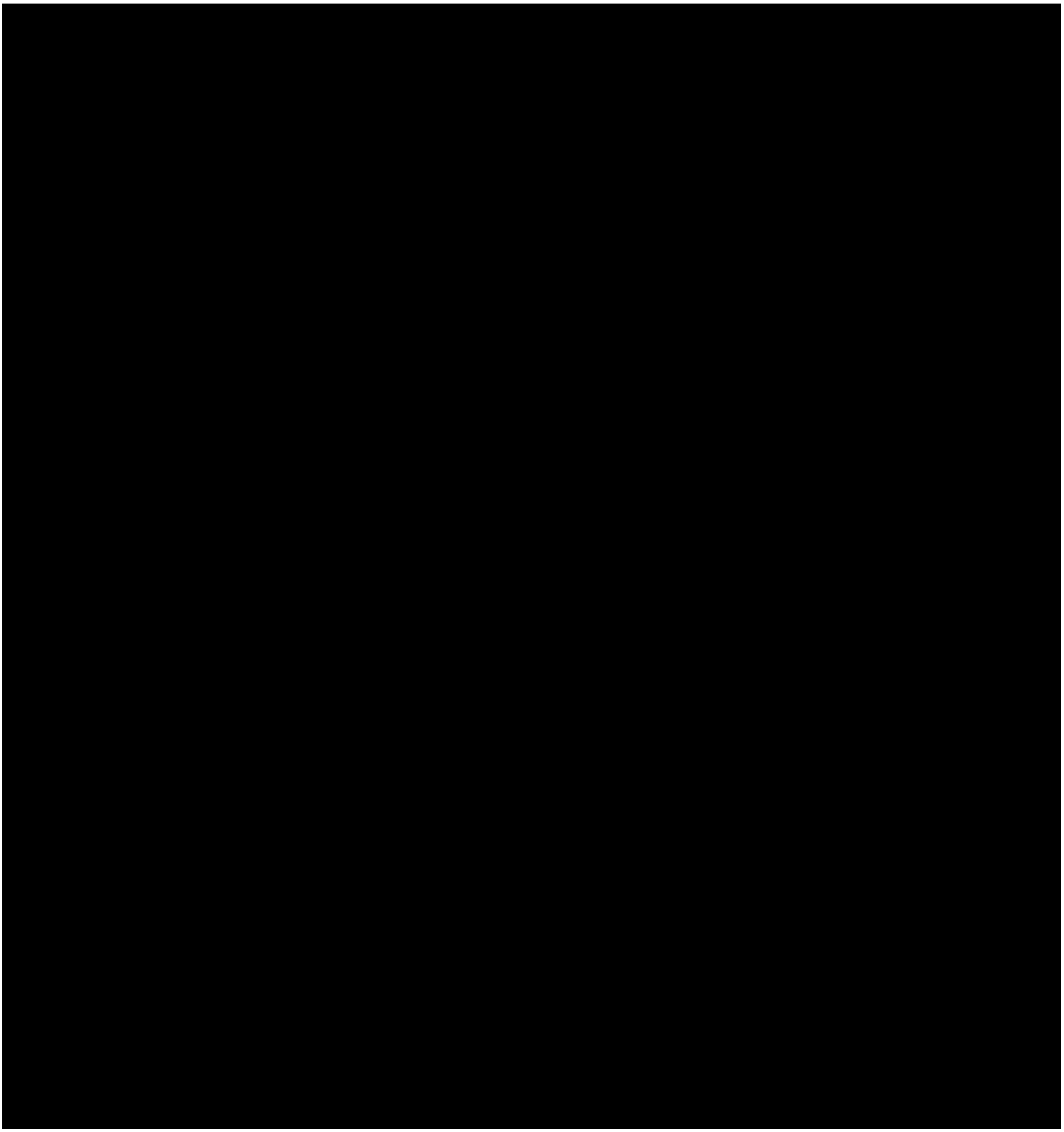


Exhibit 8D

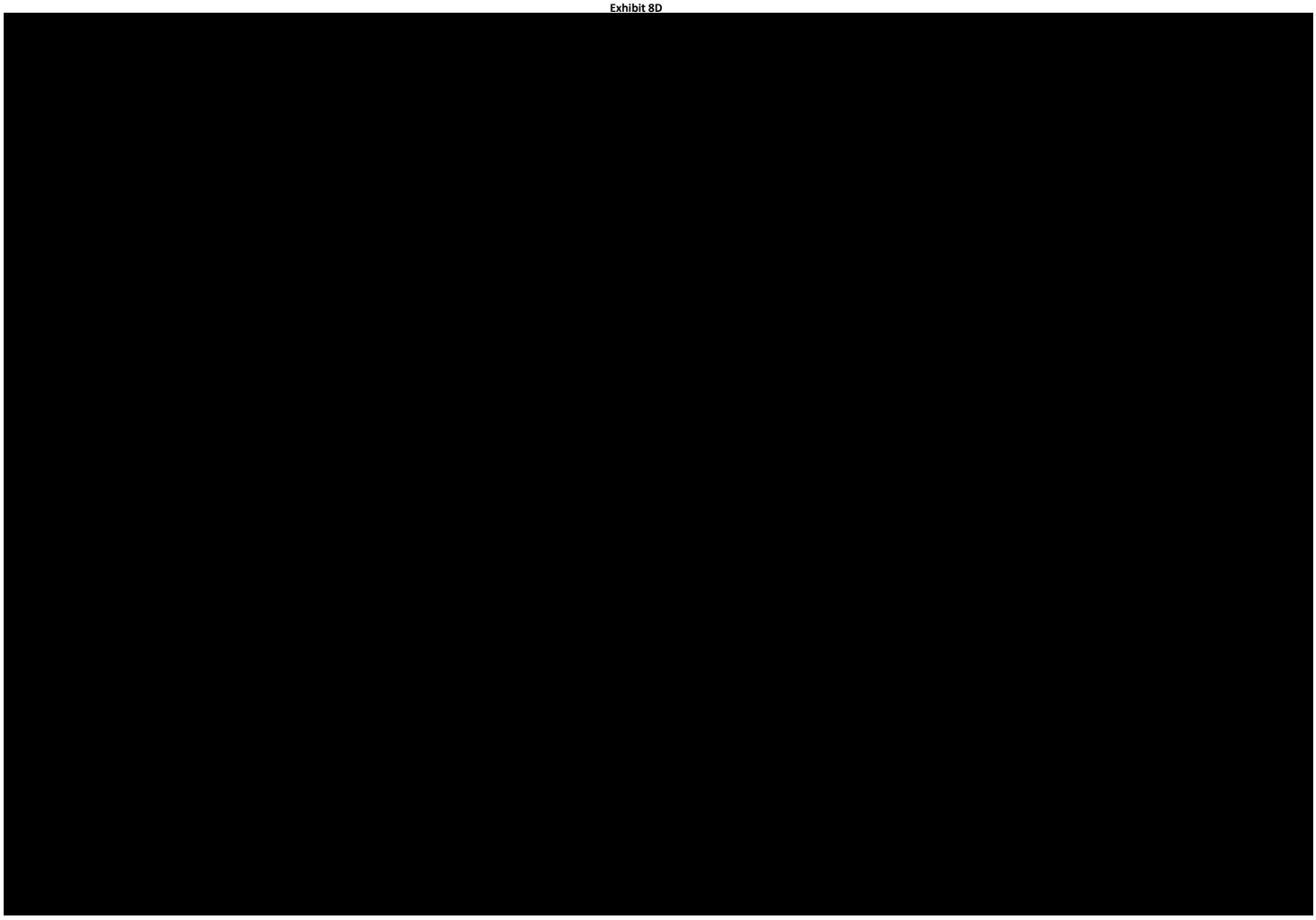


Exhibit 8E

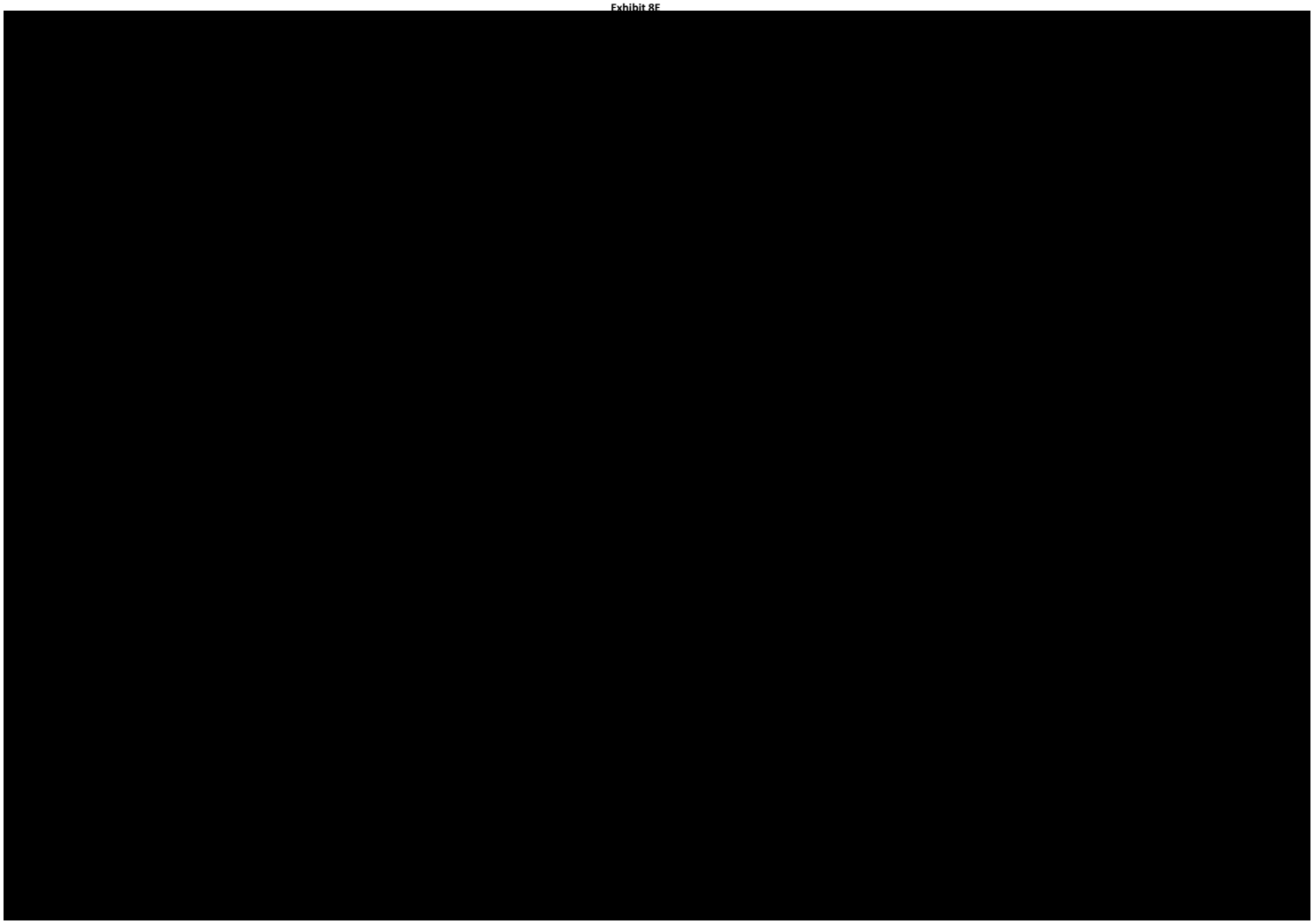


Exhibit 8F

Exhibit 9

OEM Input Costs Are Passed Through to Initial Retail Prices:

Exhibit 10A
Pass-through by Cost Change Size, Fixed Effects (FE) vs. First Differences (FD)

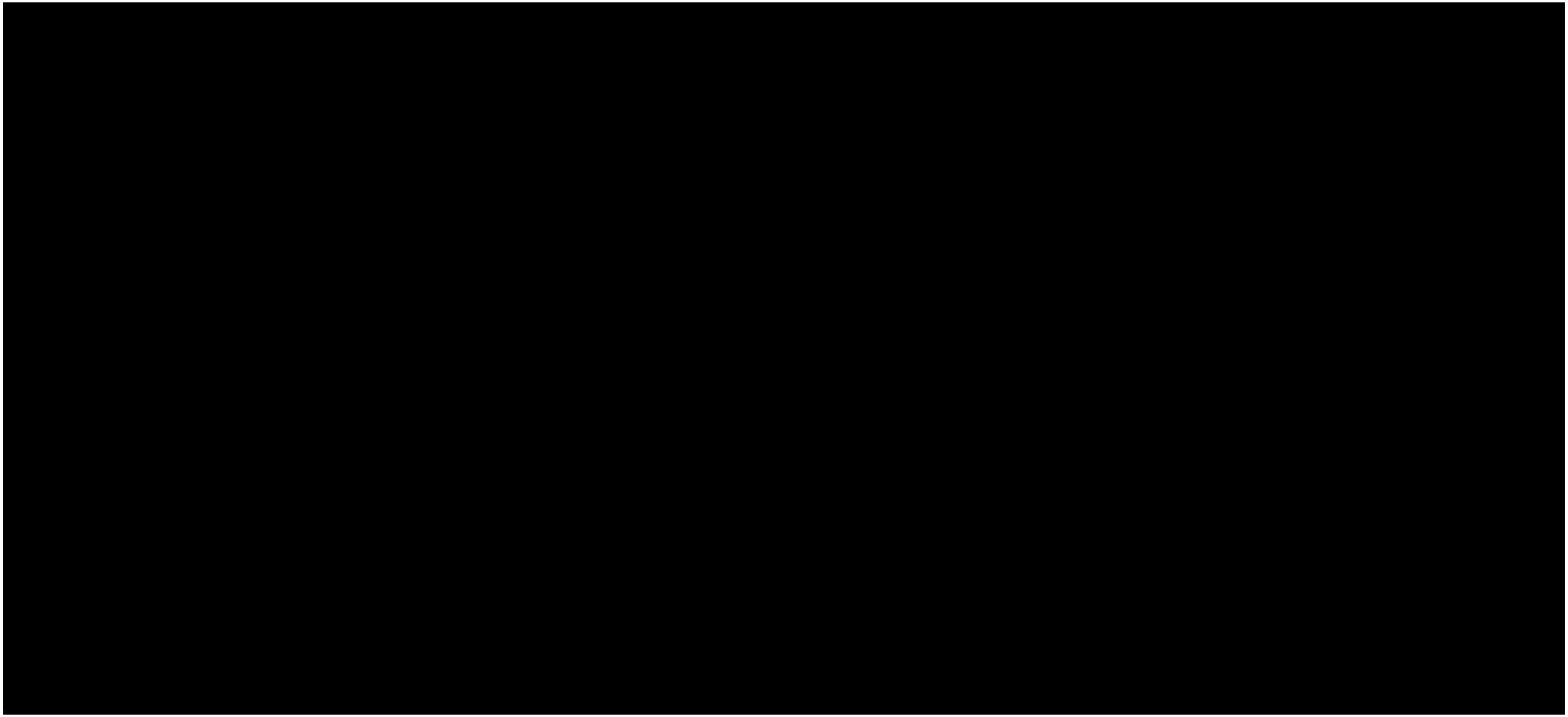


Exhibit 10B

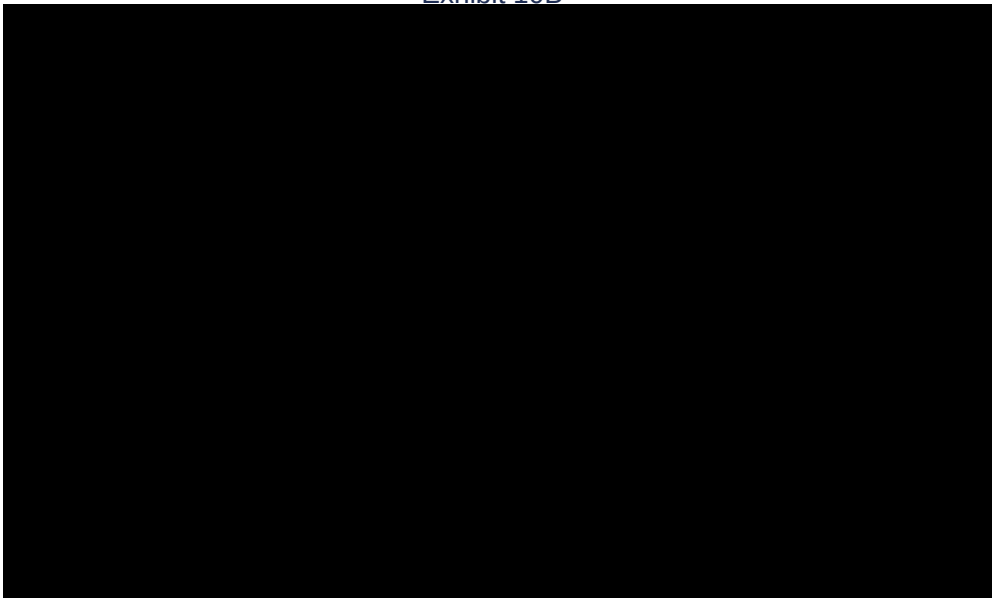


Exhibit 10C

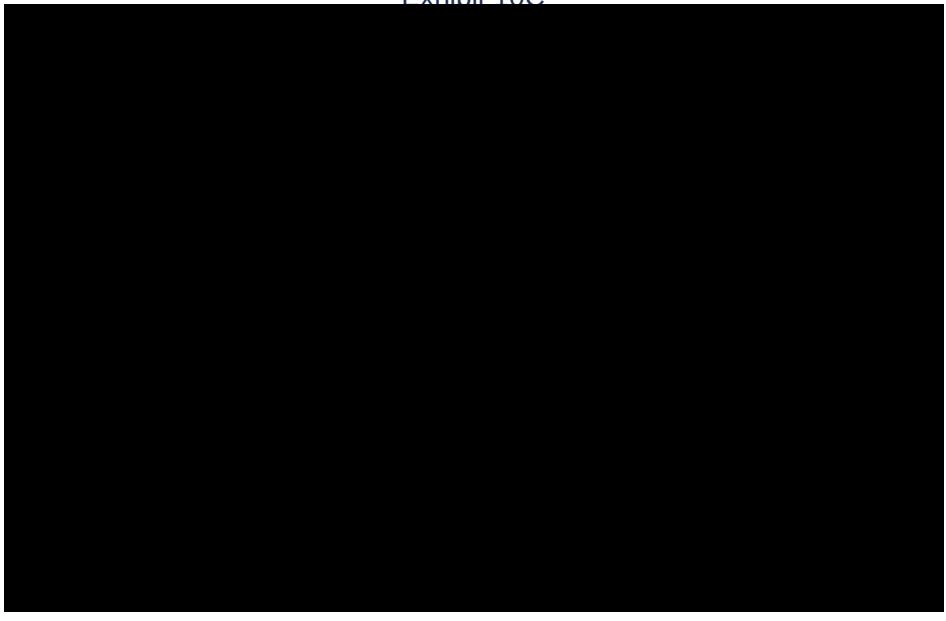


Exhibit 10D

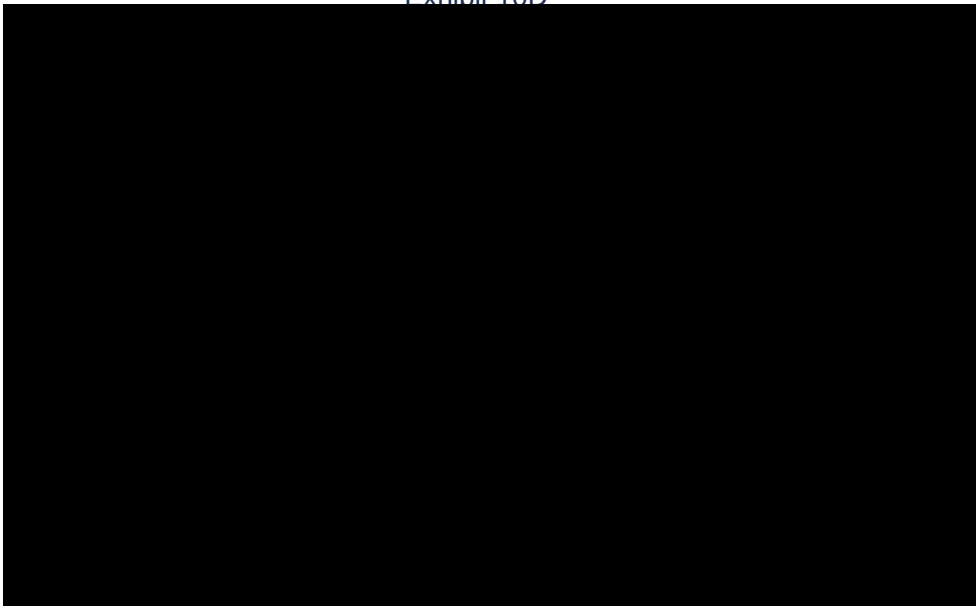


Exhibit 10E

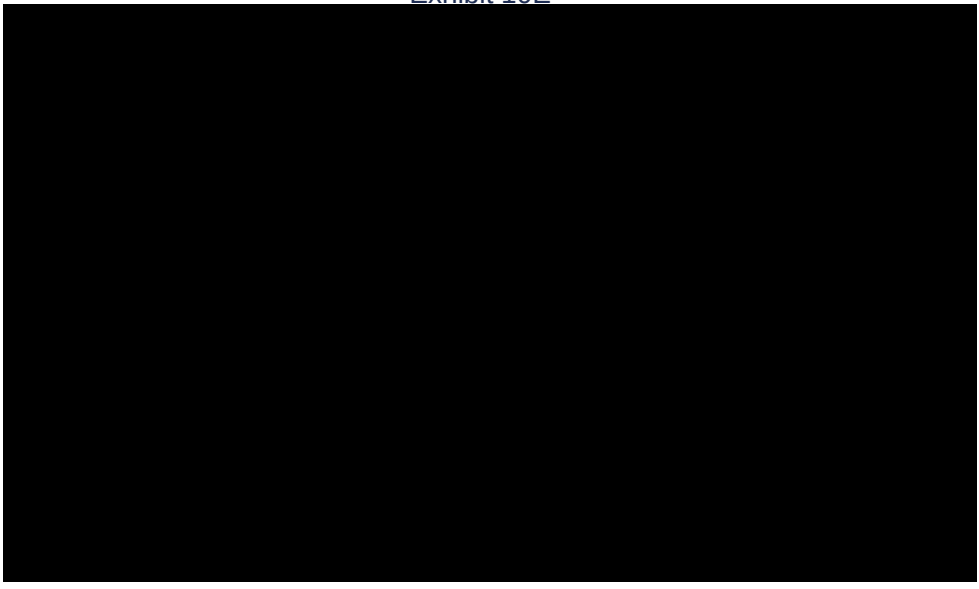


Exhibit 10F

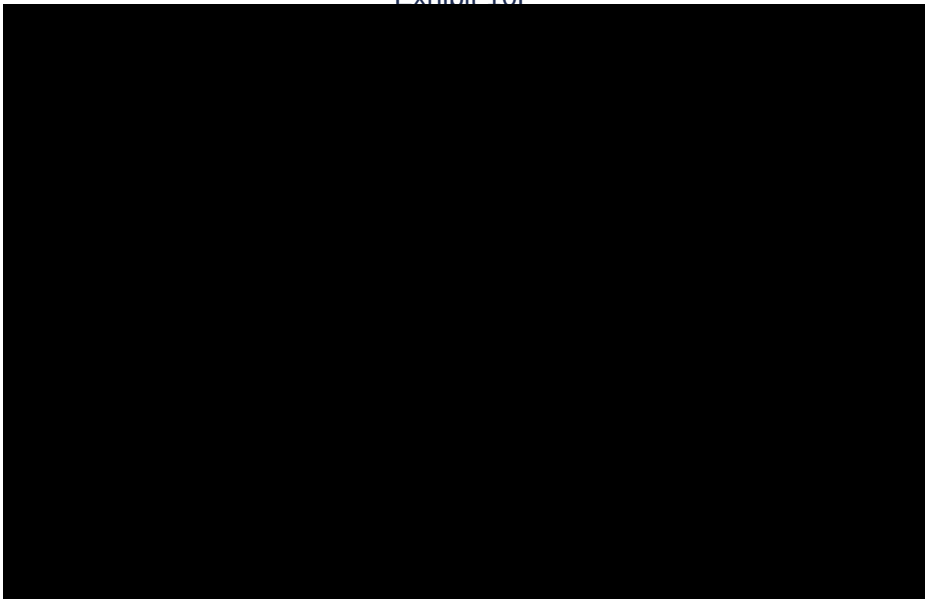


Exhibit 10G

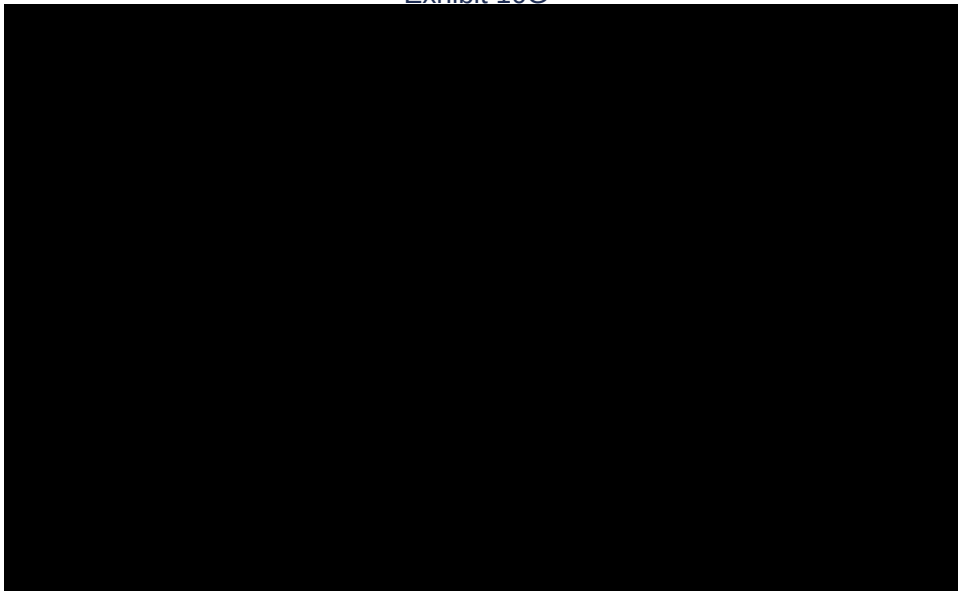


Exhibit 10H

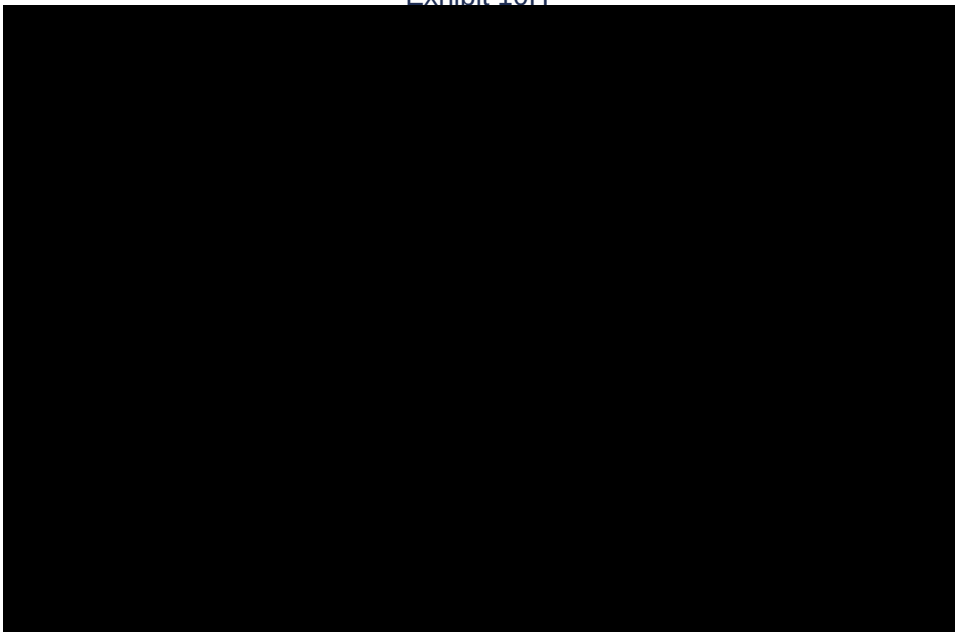


Exhibit 10I

Exhibit 10J

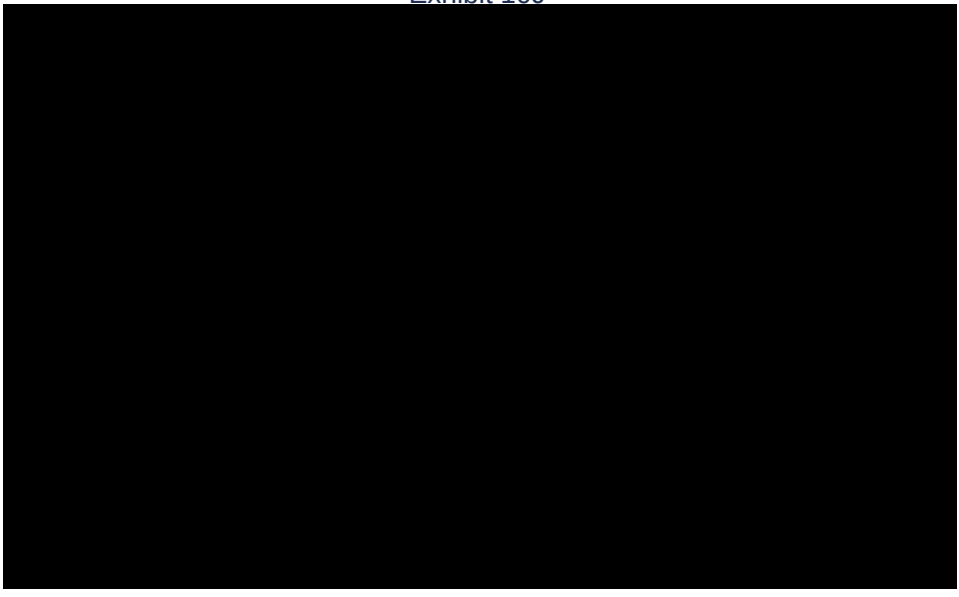


Exhibit 11A
Pass-through Above and Below a Cost Change Threshold, by Threshold

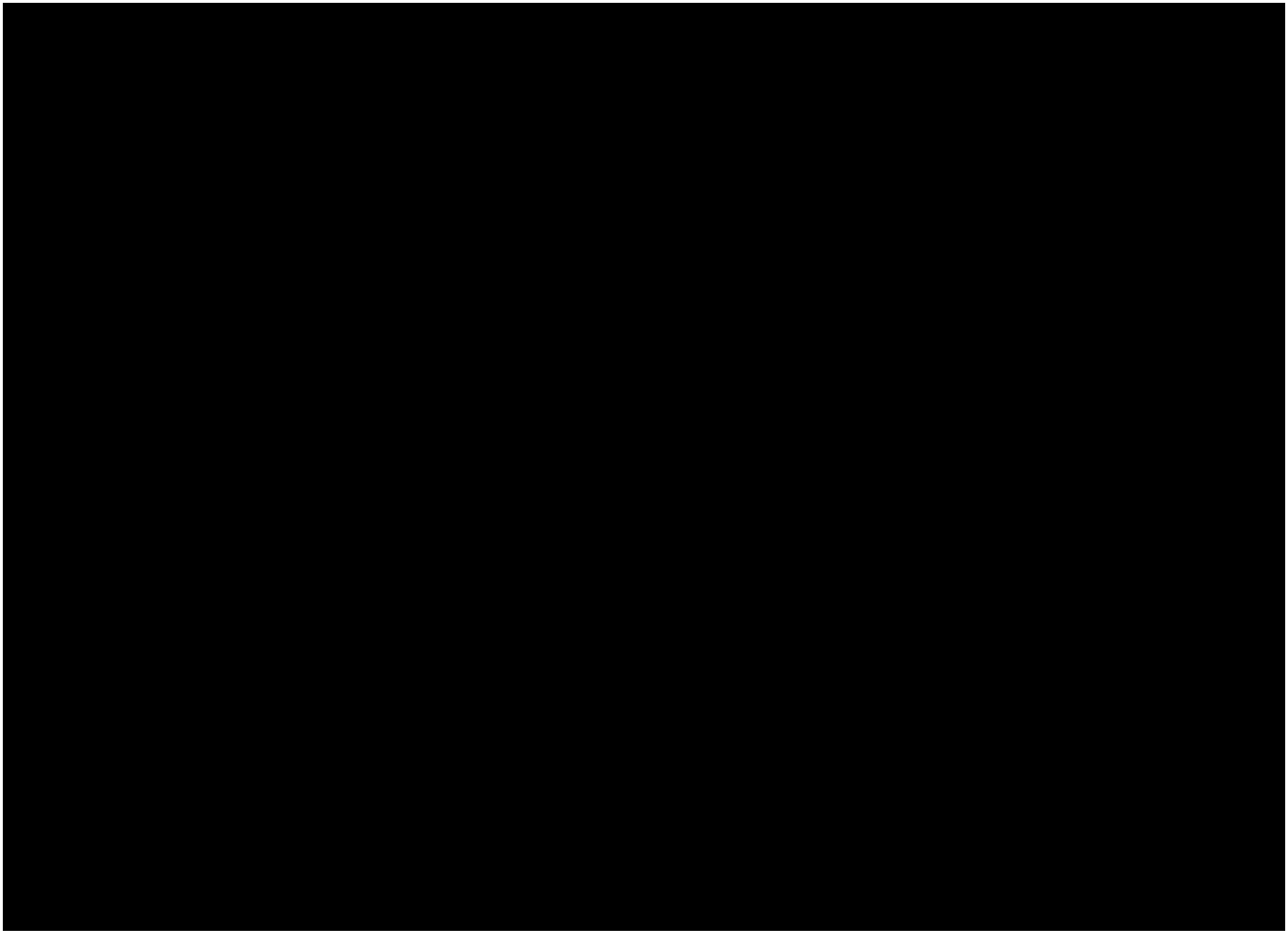


Exhibit 11B

Exhibit 11C

Exhibit 11D

Exhibit 11E

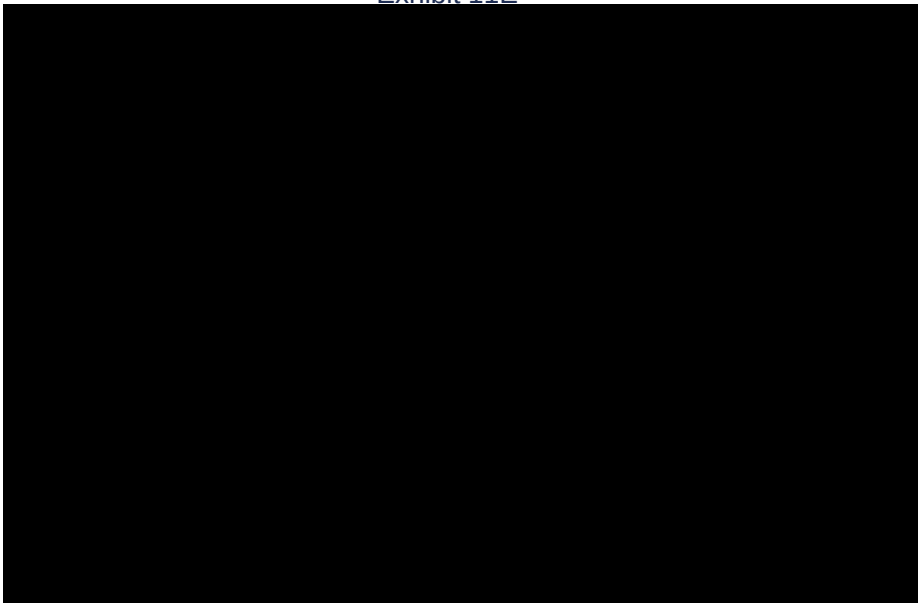


Exhibit 11F

Exhibit 11G

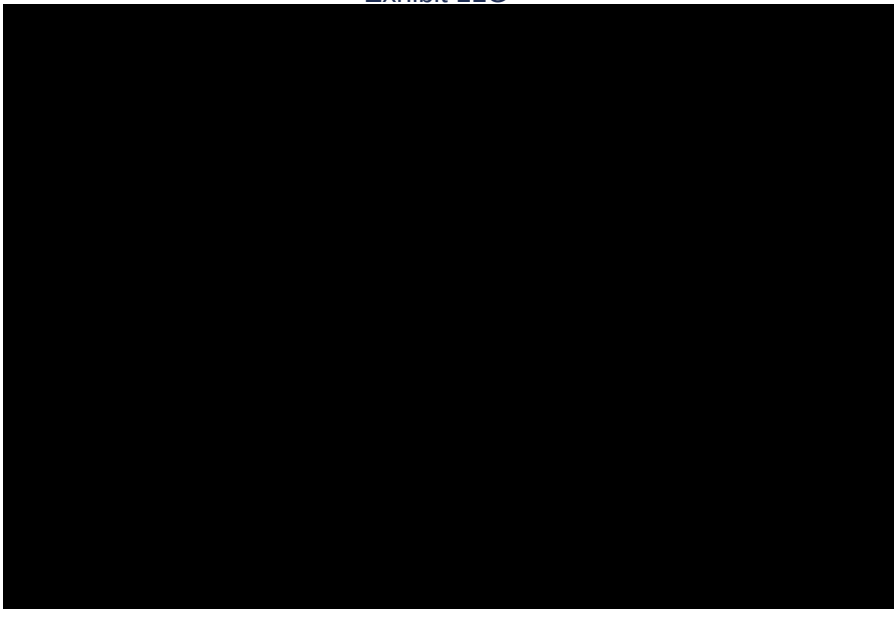


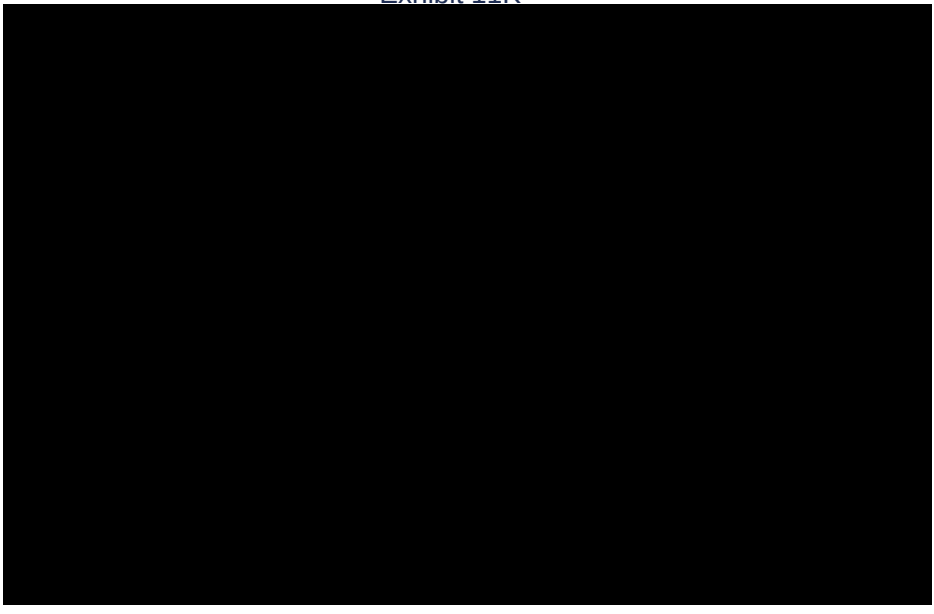
Exhibit 11H

Exhibit 11I

N
is

Exhibit 11J

Exhibit 11K



APPENDIX

Exhibit A.0
Average Pass-Through Rate Calculation (Exemplary)

	WW Units 2003Q2 to 2009Q2 (000s)[1]	Rest of World Units 2003Q2 to 2009Q2 (000s)[2]	US Units 2003Q2 to 2009Q2 (000s)[3]	Pass-Through Weighted Average Across All Channels[4]
Desktops	907,338	686,887	220,451	100.0%
Laptop	539,120	389,460	149,660	100.0%
Drives[5]	16,865	12,550	4,315	89.2%
			Average Pass-Through Across All Products and Channels	99.9%

Sources and Notes:

1. Worldwide Shipments Sum of Units for the period 2003Q2 to 2009Q2 from IDC for Desktops and Portable PCs. IDC WW PC Tracker_2012Q4_NathanInc.xls.
2. Rest of World Shipments Sum of Units for the period 2003Q2 to 2009Q2 from IDC for Desktops and Portable PCs. IDC WW PC Tracker_2012Q4_NathanInc.xls.
3. USA Shipments Sum of Units for the period 2003Q2 to 2009Q2 from IDC for Desktops and Portable PCs. IDC WW PC Tracker_2012Q4_NathanInc.xls.
4. See Exhibit A.1.
5. Standalone drive units are estimated from desktop and laptop units using an estimate that 1.152546% of ODD sales are of external drives. This percent was calculated based on internal and external units sold by PLDS, HLDS, Quanta, and TEAC for the period 2003Q2 - 2009Q2.

Exhibit A.1
Average Pass-Through Rate Calculations by Product and Supply Channel (Exemplary)

Desktops

	Pass-through rates by supply channel segment[1]					
Pass-through supply channel	**Distributors**	**Computer Makers**	**Distributors**	**Retailers**	**Total pass-through rate[2]**	**Weight[3]**
Distributors->Computer Makers->Product Distributors->Retailers	102%	112%	102%	96%	100%	4.0%
Distributors->Computer Makers->Retailers	102%	112%		96%	100%	6.3%
Distributors->Computer Makers	102%	112%			100%	12.3%
Computer Makers->Product Distributors->Retailers		112%	102%	96%	100%	13.7%
Computer Makers->Retailers		112%		96%	100%	21.5%
Computer Makers		112%			100%	42.1%
Average					100%	100.0%
Weighted average					100%	

Laptops

	Pass-through rates by supply channel segment[1]					
Pass-through supply channel	**Distributors**	**Computer Makers**	**Distributors**	**Retailers**	**Total pass-through rate[2]**	**Weight[3]**
Distributors->Computer Makers->Product Distributors->Retailers	102%	107%	102%	106%	100%	4.0%
Distributors->Computer Makers->Retailers	102%	107%		106%	100%	6.3%
Distributors->Computer Makers	102%	107%			100%	12.3%
Computer Makers->Product Distributors->Retailers		107%	102%	106%	100%	13.7%
Computer Makers->Retailers		107%		106%	100%	21.5%
Computer Makers		107%			100%	42.1%
Average					100%	100.0%
Weighted average					100%	

Drives

	Pass-through rates by supply channel segment[1]					
Pass-through supply channel	**Distributors**	**Computer Makers**	**Distributors**	**Retailers**	**Total pass-through rate[2]**	**Weight[3]**
Distributors->Computer Makers->Product Distributors->Retailers	103%	88%	103%	98%	93%	3.8%
Distributors->Computer Makers->Retailers	103%	88%		98%	90%	6.0%
Distributors->Computer Makers	103%	88%			91%	11.7%
Computer Makers->Product Distributors->Retailers		88%	103%	98%	90%	13.0%
Computer Makers->Retailers		88%		98%	87%	20.4%
Computer Makers		88%			88%	39.9%
Retailer				98%	98%	4.8%
Direct to Consumer					N/A	0.4%
Average (excludes Direct to Consumer)					91%	100.0%
Weighted average (excludes Direct to Consumer)					89%	

Sources and Notes:

1. See Exhibits A.2, A 3, and A.4. Equal to weighted average pass-through rates by supply channel segment.
2. The total pass-through rate for each channel equals the product of the pass-through rates for each segment of the channel. For example, the total pass-through rate for the uppermost channel for Desktops equals the Distributor rate (102%) x Computer Maker rate (112%) x Distributor rate (102%) x Retailer rate (96%) = 112%. Capped at 100%.
3. The weight for each channel is the share of total revenue that flows through that channel, which equals the product of the revenue shares that flow through each segment of the channel. See Exhibit A.5.

Exhibit A.2
Pass-Through for Desktops (Exemplary)

[redacted]

Exhibit A.3
Pass-Through for Laptops (Exemplary)

Exhibit A.4
Pass-Through for Drives (Exemplary)

Exhibit A.5
Revenue Share by Supply Channel Segment (Exemplary)

Shares by Supply Channel Segment	Desktops	Laptops	Drives
ODD Manufacturer Sales[1]			
A. Share to Distributors	N/A	N/A	21.5%
B. Share to Computer Makers	N/A	N/A	73.3%
G. Share to Retailers	N/A	N/A	4.8%
H. Direct to Consumer	N/A	N/A	0.4%
Computer Maker Sales[2]			
C. Direct Sales Share	54.5%	54.5%	54.5%
D. Indirect Sales Share	45.5%	45.5%	45.5%
Computer Maker Indirect Sales[3]			
E. Share to Product Distributors	38.8%	38.8%	38.8%
F. Share to Retailers	61.2%	61.2%	61.2%

Shares by Supply Channel[4]	Desktops	Laptops	Drives
Distributors->Computer Makers->Product Distributors->Retailers[5]	4.0%	4.0%	3.8%
Distributors->Computer Makers->Retailers[6]	6.3%	6.3%	6.0%
Distributors->Computer Makers[7]	12.3%	12.3%	11.7%
Computer Makers->Product Distributors->Retailers[8]	13.7%	13.7%	13.0%
Computer Makers->Retailers[9]	21.5%	21.5%	20.4%
Computer Makers[10]	42.1%	42.1%	39.9%
Retailers[11]	N/A	N/A	4.8%
Direct to Consumer[12]	N/A	N/A	0.4%

Sources and Notes:

1. These numbers will be further refined as analysis continues.
2. "Market Making in the PC Industry," Personal Computing Industry Center, March 2007, p. 5. For Desktops, Laptops, and Drives, product makers' direct sales share is the share in 2005 (54.46%). Computer makers' indirect sales share equals 100% - Computer makers' direct sales share.
3. For Desktops, Laptops, and Drives, distributor and retailer shares are based on an estimate of HP's sales to distributors as a share of its total indirect product sales from 2003 to 2009.
4. The share of total revenue that flows through each supply channel equals the product of the revenue shares that flow through each segment of the channel.
5. A x D x E for Drives; A x D x E / (A + B) for Desktops and Laptops, using Drives' A and B.
6. A x D x F for Drives; A x D x F / (A + B) for Desktops and Laptops, using Drives' A and B.
7. A x C for Drives; A x C / (A + B) for Desktops and Laptops, using Drives' A and B.
8. B x D x E for Drives; B x D x E / (A + B) for Desktops and Laptops, using Drives' A and B.
9. B x D x F for Drives; B x D x F / (A + B) for Desktops and Laptops, using Drives' A and B.
10. B x C for Drives; B x C / (A + B) for Desktops and Laptops, using Drives' A and B.
11. G.
12. H.

Exhibit A.6
Retail Store Types and "Top 25" Companies Included in Pass-Through Analysis

TWICE Store Type	Included Companies	Type Share of Top 25
Electronics/Appliance stores/Multi-regional	Best Buy, Fry's	29.0%
Consumer direct/Internet shopping	Dell, HP, Newegg, Amazon	24.3%
Mass Merchants	Walmart, Sears	13.7%
Home office stores	Office Depot, OfficeMax	6.9%
Computer stores	CompUSA, Micro Center	6.0%
Sales of Included Store Types as Share of Total "Top 25" Retailer Sales		79.8%

Sources and Notes:

1. TWICE Top 25 PC Retailer Lists, 2004-2009